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FIFTH ANNUAL REPORT
OF THE
STATE ENTOMOLOGIST
OF INDIANA

C. H. BALDWIN
1911-1912

E.D.
I 39.3

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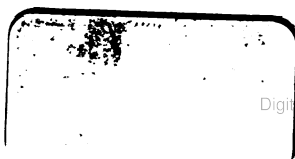
OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY.

38,467.

Exchange.

January 17, 1913.





A PROBLEM FOR THE PLANT PHYSIOLOGIST. (Original.)

FIFTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF INDIANA

C. H. BALDWIN

1911-1912

INDIANAPOLIS :
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1912

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
October 24, 1912.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF THE AUDITOR OF STATE,
INDIANAPOLIS, October 28, 1912.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

W. H. O'BRIEN,
Auditor of State.

OCTOBER 28, 1912.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, October 28, 1912.

L. G. ELLINGHAM,
Secretary of State.

Received the within report and delivered to the printer October 28, 1912.

ED D. DONNELL,
Clerk Printing Board.

LETTER OF TRANSMITTAL.

INDIANAPOLIS, IND., October 21, 1912.

HONORABLE THOMAS R. MARSHALL, *Governor of Indiana*:

Dear Sir—It is with pleasure that I present herewith the fifth annual report of this office. The work is designed primarily to acquaint the public with some of the more destructive forms of insects and plant diseases that are prevalent in Indiana, and also methods for controlling them. A part of the report is devoted to apiary inspection.

Respectfully,

C. H. BALDWIN,
State Entomologist.

FINANCIAL STATEMENT OF STATE ENTOMOLOGIST.

State Appropriation \$15,000 00

Salaries:

| | |
|-------------------------|------------|
| Baldwin, C. H..... | \$2,391 63 |
| Erbaugh, D. W..... | 1,200 00 |
| Smith, Everett | 1,200 00 |
| Mulligan, Edward W..... | 893 75 |
| Kindig, B. F..... | 582 65 |
| Haworth, Opal | 560 00 |
| Swallow, A. P..... | 550 00 |
| Morrison, Harold | 550 00 |
| Bartlett, C. L..... | 539 00 |
| Teeter, G. H..... | 244 96 |
| Douglass, B. W..... | 208 35 |
| Siebenthal, Maud | 131 25 |
| Davis, Webster | 112 00 |
| Alexander, Grace | 75 00 |
| Dietz, Harry F..... | 75 00 |
| Hasselman, L. B..... | 72 00 |
| Wallace, F. N..... | 10 00 |
| Ratliff, W. S..... | 6 00 |
| Wade, F. B..... | 1 50 |

Total salaries \$9,403 09

| | |
|-------------------------------------|----------|
| Office and Laboratory Supplies..... | 689 61 |
| Express | 152 22 |
| Telephone and Telegraph..... | 140 07 |
| Postage | 561 88 |
| Hotel | 1,306 94 |
| Livery | 364 75 |
| Transportation | 1,224 61 |
| Returned to State..... | 1,156 83 |

\$15,000 00 \$15,000 00

An itemized account of the above expenditures is on file with the Auditor of State.

SURVEY OF WORK DONE BY THE OFFICE DURING THE PAST YEAR.

On account of the increased number of people learning of the work of this department, there has been a gradual increase in the amount of correspondence received asking about the various insects and plant diseases with which they are troubled. To meet this demand and give prompt attention, blanks were designed for reporting on specimens received. Elsewhere in this report are shown copies of these blanks.

Another phase of the work that has met with a great deal of approval is public demonstration meetings. These meetings were held in a number of localities where there seemed to be a demand for an actual demonstration in methods of spraying, pruning, top grafting and other orchard operations that could be demonstrated during the winter months. At these demonstration meetings discussions, along whatever lines questions happened to be asked, made them very interesting and we believe profitable to those attending. The principal part of field work carried on during the summer work has been devoted to nursery, premise and bee inspection. At the time of this writing 131 certificates have been issued for the sale of nursery stock. It is probable that more will be issued after certain treatment on the part of the nurseryman has been carried out. In several instances a second inspection has seemed necessary on account of the nature of the treatment that has been required. Nurserymen of the State have learned that in order to receive certificates to sell their stock they must not only give their places care in the way of cultivation, etc., but must also keep it clean from injurious insects and diseases—especially those that would be transported on dormant stock.

Considerable work has been carried on in the inspection of premises. In some localities of the State where the orchard interests have become developed and the owners of large orchards are putting forth every possible effort to keep them free from pests, we have assisted in such localities by making inspection of the premises for several miles around for the purpose of preventing the spread of injurious insects. These inspections have been carried on for the most part to save orchards and nurseries from the attacks of San Jose scale. There are several very limited areas in the

State over which San Jose scale has not yet spread. There are also some sections where San Jose scale has been held in check in rather badly infested areas as a result of carrying out proper spray methods.

It will be the purpose of this office to make inspection of infested premises as far as possible and give instructions for carrying out certain regulations necessary in controlling pests that may be present. Our attention will, of course, be devoted to those localities where an earnest effort is being put forth on the part of some of the citizens to hold the pests in check. In any case, it is only by co-operation of property owners that will result in any amount of good in this respect.

Inspection of apiaries is discussed in detail in another part of this report by Messrs. Erbaugh and Kindig. They have been busy at this phase of the work from the time the bees began to work in the spring until it was no longer practical to handle them in the fall.

Educational exhibits have been made at the Indiana Apple Show, Indiana State Fair, and also at the Harrison County Fair, Corydon, Ind.; Elkhart County Fair, Goshen, Ind.; Lagrange Corn Show, Lagrange, Ind., and at the Steuben County Fair, Angola, Ind. These exhibits attract a great deal of attention and it will be the policy of the department in the future to increase its activities along this line of work. It is impossible for a horticulturist to accomplish very much good in his efforts to combat insect pests and diseases unless he is first able to diagnose the trouble and has some information regarding the pests that he is fighting. The primary purpose of the exhibit is to furnish an object lesson for the public to acquaint it with the insect pests and fungous diseases which are annually causing it so much loss.

Demonstration orchards have been conducted at Plainfield, Greensburg, Laporte and Noblesville. The orchard owners have furnished labor and material for carrying out the work, with the exception of the assistance that has been possible to furnish by a representative from this office. The results of demonstration work of this sort is evidenced by the number of visitors who come to the orchards to witness the work as well as the results of it. The generous co-operation with this office on the part of the orchard owners is greatly appreciated and their immediate communities are certain to reap benefits from the object lessons taught by such demonstration orchards.

In the work of preparing this report I am greatly indebted to the deputies of this office who have assisted me directly in writing and illustrating it, and also for the valuable information that the deputies as well as many interested citizens have furnished relative to the insect and plant disease situation in various parts of the State. Also, the conscientious efforts of each one of the deputies in the discharge of whatever duty has been assigned him, is very praiseworthy. Special acknowledgment is made to E. Dwight Sanderson, B. M. Duggar, the United States Department of Agriculture and the Agricultural Experiment Stations of the various States—the publications of all having been consulted freely in the preparation of this report.

**OFFICE OF
STATE ENTOMOLOGIST
LABORATORY REPORT No. 1**

INDIANAPOLIS, IND.

Mr.....

Examination of the specimen of.....
from you shows:.....

Remarks:
.....
.....
.....
.....
.....
.....
.....
.....

.....
State Entomologist.

Per.....

Specimen received.....

Report mailed.....

FIFTH ANNUAL REPORT

OFFICE OF
STATE ENTOMOLOGIST
LABORATORY REPORT No. 2

 INDIANAPOLIS, IND.

Mr.

.....

Upon examination the insects sent in by you proves to be:
insect

.....
.....
.....

Remarks:

.....
.....
.....
.....
.....
.....

.....

State Entomologist.

Per.

Specimen received.....

Report mailed.....

INDIANA NURSERYMEN.

| Name. | Location. | Kind of Stock Certificate Covers. |
|-------------------------|------------------------|--|
| A | | |
| Abraham Bros..... | Martinsville..... | General. |
| Anglin, J. K..... | Etna Green..... | Small fruit plants. |
| Alstatt, John..... | Corydon..... | General. |
| B | | |
| Back, Henry..... | New Trenton..... | General. |
| Baldwin, T. A..... | Oxford..... | Small fruit plants. |
| Barnard, A. J..... | Westville..... | Strawberry plants. |
| Barnes, M. & Co..... | College Corner, O..... | General. |
| Beck, H. E..... | Michigan City..... | Small fruit plants. |
| Beckner, Horace..... | Greenfield..... | General. |
| Bell, C. A..... | Borden..... | Strawberry plants. |
| Bennett Nur. Co..... | Lafayette..... | General. |
| Billingsly & Son..... | Greenwood..... | General. |
| Bird, E. E..... | Depauw..... | Peach..... |
| Borders, R. M..... | Borden..... | Strawberry plants. |
| Bowman, R. W..... | Pennville..... | Small fruit plants. |
| Buck, H. F..... | Elberfield..... | General. |
| Burkhardt & Son..... | Indianapolis..... | General. |
| C | | |
| Cain, W. D..... | Shelburn..... | Small fruit plants. |
| Campbell, Harry..... | Warsaw..... | Small fruit plants. |
| Cathcart, Frank..... | Bristol..... | Strawberry plants. |
| Cathcart, A. Y..... | Bristol..... | General. |
| Childers, Geo. W..... | Valeene..... | General. |
| Cochran, L. B..... | Greensburg..... | Small fruit plants and shade trees. |
| Cook, J. L..... | Warsaw..... | Strawberry plants. |
| Cooley, Simpson..... | Borden..... | Strawberry plants. |
| Collins, Lamar..... | Underwood..... | General. |
| Cowing, Granville..... | Muncie..... | Rose. |
| Cosner, Alfred..... | Stilesville..... | General. |
| Cunningham Nur. Co..... | Rising Sun..... | General. |
| Cunningham Nur. Co..... | Seymour..... | General. |
| D | | |
| Daniels, Salvaner..... | Doans..... | Apple. |
| Davis, Geo. W..... | Brazil..... | Strawberry plants. |
| Deer, F. H..... | Valparaiso..... | Strawberry plants. |
| Dutter, Jerry..... | Angola..... | Strawberry and raspberry plants. |
| Doans, J. L. & Co..... | Westfield..... | Shade and ornamentals. |
| Dykeman, Richard..... | Plymouth..... | Shrubs, evergreens, shade trees. |
| E | | |
| Egloff, Jos..... | Ferdinand..... | General. |
| Erwin, T. J..... | Mt. Vernon..... | Chestnut. |
| F | | |
| Farmland Nur. Co..... | Farmland..... | General. |
| Fisher, Philip..... | Borden..... | Strawberry plants. |
| Fulhart, Chas..... | Muncie..... | General. |

INDIANA NURSERYMEN—Continued.

| Name. | Location. | Kind of Stock Certificate Covers. |
|-------------------------------------|---------------------|---|
| G | | |
| Gaar, M. H..... | Cambridge City..... | General. |
| Gaar, W. H..... | E. Germantown..... | General. |
| Gainey, S. C..... | Doans..... | Peach and apple. |
| Gallimore, W. F..... | Bloomfield..... | General. |
| Garber, D. M. & Sons..... | Pierceton..... | Small fruit plants. |
| Garret, B. F..... | Burns City..... | General. |
| Girton, L. R..... | Bristol..... | Raspberry and strawberry plants. |
| Goehler, A. H..... | Urbana..... | Small fruit plants. |
| Goss, D. L..... | Borden..... | Strawberry plants. |
| Graham, Chas..... | Jeffersonville..... | General. |
| Graham, J. K..... | New Albany..... | General. |
| Gray, Alva G..... | Pekin-Salem..... | Black raspberry, apple, peach, pear, strawberry. |
| H | | |
| Haas, Harry..... | Terre Haute..... | General. |
| Halleck Nur. Co..... | Fair Oaks..... | General. |
| La Hayne, Wm..... | Chesterton..... | Small fruit plants. |
| Hazen, Smith..... | Hatfield..... | General. |
| Heller Bros. & Co..... | New Castle..... | Ornamentals. |
| Henby, J. K. & Son..... | Greenfield..... | General. |
| Henry, D. G..... | Laporte..... | Small fruit plants. |
| Hobbs & Sons..... | Bridgeport..... | General. |
| Hopkins, L. V..... | Maxwell..... | General. |
| Huber, M. J..... | Deerfield..... | Small fruit plants. |
| Hurraw, B. F..... | Butler..... | Small fruit plants. |
| I | | |
| Indianapolis For. & Nur. Co..... | Indianapolis..... | Catalpa. |
| Ireland, C. A..... | Brownstown..... | Strawberry and black- berry plants. |
| Ind. Exp. Sta..... | W. Lafayette..... | General. |
| J | | |
| Jackman, H. E..... | St. Joe..... | General. |
| Jarrett, J. A..... | Montpelier..... | Shade trees. |
| K | | |
| Keele, Thos..... | Westville..... | Strawberry plants. |
| Keplar, S. W..... | Pulaski..... | General. |
| Knaub, Ben..... | Mt. Vernon..... | General. |
| Krider, Vernon H..... | Middlebury..... | General. |
| L | | |
| Leroy, Frank..... | Laporte..... | Small fruit plants. |
| Lewis, David G..... | Fairmount..... | Shade trees and small fruit plants. |
| Loomis, J. M..... | Hobart..... | Strawberry plants. |
| M | | |
| Mason, B. F..... | Martinsville..... | General. |
| Martindale, Mose..... | Doans..... | General. |
| McClaren, M. C..... | Corydon..... | General. |

INDIANA NURSERYMEN—Continued.

| Name. | Location. | Kind of Stock Certificate Covers. |
|---------------------------|----------------------|--|
| McClaren, J. T. | Corydon. | General. |
| McCormick-Osborn. | Burns City. | General. |
| McElderry, Wm. | Princeton. | General. |
| McFeron, Hiram. | Columbus. | General. |
| McKown, J. T. | Greenville. | Strawberry plants. |
| Meredith, Frank. | Koleen. | General. |
| Merrill, H. R. | Brownstown. | General. |
| Meeker, H. H. | Crown Point. | General. |
| Moffitt, Frank. | Carmel. | Strawberry plants. |
| Moore, J. P. | Greenfield. | General. |
| Moyer, G. N. | Laketon. | General. |
| Murr, A. S. | Depauw. | Peach. |
| Murray, A. M. | Goshen. | General. |
| N | | |
| Nation, Chas. | Gilead. | Strawberry and raspberry plants. |
| Neet, Geo. W. | Valparaiso. | Small fruit plants. |
| Nufer, Alfred. | Bremen. | General. |
| P | | |
| Portland Nur. Co. | Portland. | General. |
| O | | |
| Ohio Valley Nur. Co. | Lake. | General. |
| Osborn, Arthur. | Spiceland. | Pawpaw. |
| P | | |
| Palmer, Fred. | Indianapolis. | Shade trees. |
| Phelps, W. W. | Noblesville. | Catalpa and maple. |
| Purcell, F. A. | Vincennes. | Black raspberry plants. |
| R | | |
| Ragle, Amos. | Elnora. | General. |
| Reed, Wm. H. | Hanover. | General. |
| Reed, W. C. | Vincennes. | General. |
| Richerick, J. D. | Goshen. | Small fruit plants. |
| Robb, J. W. | Borden. | Strawberry plants. |
| Roerk, F. M. | Borden. | Strawberry plants. |
| Roerk, T. J. | Borden. | Strawberry and black- berry plants. |
| Rogers, Sig. | Bloomfield. | Strawberry and raspberry plants. |
| S | | |
| Shields Bros. | Charlottsville. | General. |
| Shields & Son. | Anderson. | Apple, peach and cherry. |
| Sibert, A. B. | Rochester. | Strawberry plants. |
| Simpson & Son. | Vincennes. | General. |
| Sleeper Bros. | Fowler. | General. |
| Smith, J. E. | Muncie. | General. |
| Smith, Orin. | Butler. | Strawberries. |
| Snoddy Nur. Co. | Lafayette. | General. |
| Stout, W. C. | So. Bend. | Small fruit plants. |
| Swaim, H. H. | So. Bend. | Small fruit plants. |

INDIANA NURSERYMEN—Continued.

| Name. | Location. | Kind of Stock Certificate Covers. |
|------------------------|------------------|--------------------------------------|
| T | | |
| Teas, E. Y. & Co..... | Centerville..... | Ornamental shrubs. |
| Thomas, Emory..... | Borden..... | Strawberry plants. |
| Todd, H. A..... | Bedford..... | Small fruit plants. |
| W | | |
| Walker, F..... | New Albany..... | General. |
| Ward, Thomas J..... | St. Mary's..... | General. |
| Weber, Carl..... | Greenfield..... | General. |
| Weilbrenner, Carl..... | Mt. Vernon..... | Pecans. |
| Winchell, G. W..... | Tobinsport..... | General. |
| Wines, W. H..... | Akron..... | Small fruit plants. |
| Wood, E. M..... | N. Madison..... | Apple, pear and peach. |
| Y | | |
| Ynzonides Bros..... | Crown Point..... | General. |
| Young, John..... | Odon..... | Small fruit plants. |



SPRAYING AT PLAINFIELD. (Original.)

INSECTICIDES.

The insecticides may be divided into four groups according to their function. The first group—contact insecticides—are those that kill by coming in contact with the insects. In spraying with a material of this sort, therefore, great care must be exercised to get the material directly on the insects. The next group—stomach poisons—are placed upon the food material of the insects and may precede the appearance of the particular pest for which they are applied and still be effective. The main point to be kept in mind in connection with the stomach poison is to get the poison spread thoroughly over the food material of the insect. The third group of insecticides may be called repellants as they are not designed to kill the insects in either of the two preceding ways. They are for the purpose of creating a condition or odor that is disagreeable to insect life and thereby prevent its occurrence. The last group of insecticides with which we will deal is fumigants. The fumigants are handled in such a way as to produce a gas which is poisonous to insect life. This group of insecticides is very valuable when a poisonous gas is needed to reach a secluded place where contact or any other insecticides would be impracticable. An inclosure, of course, is necessary in the use of hydrocyanic acid gas, but carbon bisulphide may be used in the fumigation of soil as the gas formed is much heavier than air and will permeate through the soil if the latter be porous.

Contact Insecticides.

No. 1. LIME-SULPHUR:

In the manufacture of lime-sulphur solution pure stone lime should be used and it should be as free as possible from magnesium. It is impracticable for one to attempt to manufacture lime-sulphur if his lime contains more than 5% magnesium. New process lime (sometimes called hydrated lime or powdered lime) may be used with good success, but it is not advisable to recommend it as there is danger of its being somewhat air slaked. The stone lime used should be absolutely free from air slaked particles. For home-made concentrated lime-sulphur the following formula is recommended:

| | |
|---------------|------------|
| Lime | 40 pounds |
| Sulphur | 80 pounds |
| Water | 50 gallons |

If stone lime comes in large lumps these should be broken up. The lime should be placed into a kettle or container holding somewhat more than 50 gallons and covered over with enough warm water to start slaking. As soon as the lime begins to slake add the sulphur which should be previously made into a fine paste with hot water. The whole mixture should then be diluted to make 50 gallons and boiling should be continued for 45 minutes. The solution should be kept as nearly to the 50 gallon mark as possible during the entire cooking period. One should have a notched stick for measuring the quantity in the kettle. When boiling is going on vigorously throw a little cold water in to stop the cooking for an instant so that an accurate measurement may be made and the solution kept at 50 gallons.

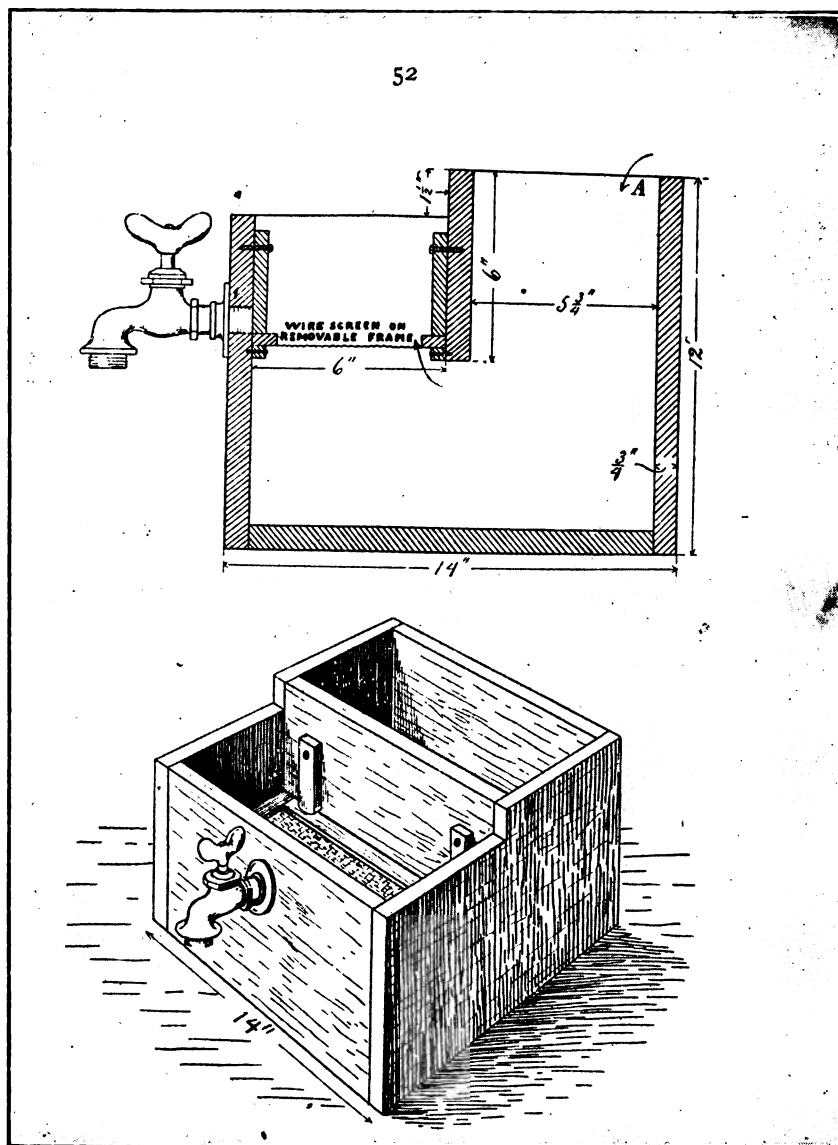
Lime-sulphur solution can be made up in this way during the winter months or during odd times. Carefully strain the solution and place in barrels with the air excluded to prevent crystallization. The hydrometer should be used to determine the density of the material and whether it is used for dormant or summer spraying, should be diluted according to the following table.

*TABLE FOR DILUTING LIME-SULPHUR SPRAY.

| Density of Solution in degrees Beaume. | Sulphur in one gallon of solution. | (Dilution for San Jose Scale.) For 1 gallon Lime-Sulphur Solution. Use. | (Dilution for Summer Spray.) For 1 gallon Lime-Sulphur Solution Use. |
|--|------------------------------------|---|--|
| 36 | 2.99 pounds. | 9 gallons water. | 45 gallons water. |
| 35 | 2.88 pounds. | 8 $\frac{3}{4}$ gallons water. | 43 $\frac{1}{4}$ gallons water. |
| 34 | 2.77 pounds. | 8 $\frac{1}{4}$ gallons water. | 41 $\frac{1}{2}$ gallons water. |
| 33 | 2.67 pounds. | 8 gallons water. | 40 gallons water. |
| 32 | 2.53 pounds. | 7 $\frac{1}{2}$ gallons water. | 37 $\frac{3}{4}$ gallons water. |
| 31 | 2.43 pounds. | 7 $\frac{1}{4}$ gallons water. | 36 $\frac{1}{4}$ gallons water. |
| 30 | 2.30 pounds. | 6 $\frac{3}{4}$ gallons water. | 34 $\frac{1}{4}$ gallons water. |
| 29 | 2.20 pounds. | 6 $\frac{1}{2}$ gallons water. | 32 $\frac{3}{4}$ gallons water. |
| 28 | 2.08 pounds. | 6 gallons water. | 31 gallons water. |
| 27 | 1.99 pounds. | 5 $\frac{3}{4}$ gallons water. | 29 $\frac{1}{2}$ gallons water. |
| 26 | 1.87 pounds. | 5 $\frac{1}{4}$ gallons water. | 27 $\frac{3}{4}$ gallons water. |
| 25 | 1.76 pounds. | 5 gallons water. | 26 gallons water. |
| 24 | 1.65 pounds. | 4 $\frac{1}{2}$ gallons water. | 24 $\frac{1}{4}$ gallons water. |
| 23 | 1.55 pounds. | 4 $\frac{1}{4}$ gallons water. | 22 $\frac{3}{4}$ gallons water. |
| 22 | 1.45 pounds. | 3 $\frac{3}{4}$ gallons water. | 21 $\frac{1}{4}$ gallons water. |
| 21 | 1.35 pounds. | 3 $\frac{1}{2}$ gallons water. | 19 $\frac{3}{4}$ gallons water. |
| 20 | 1.26 pounds. | 3 $\frac{1}{4}$ gallons water. | 18 $\frac{1}{4}$ gallons water. |
| 19 | 1.18 pounds. | 3 gallons water. | 17 gallons water. |
| 18 | 1.11 pounds. | 2 $\frac{3}{4}$ gallons water. | 16 gallons water. |
| 17 | 1.04 pounds. | 2 $\frac{1}{2}$ gallons water. | 15 gallons water. |
| 16 | 0.97 pounds. | 2 $\frac{1}{4}$ gallons water. | 14 gallons water. |
| 15 | 0.90 pounds. | 2 gallons water. | 12 $\frac{1}{2}$ gallons water. |

*Van Slyke, Bosworth and Hedges, N. Y. Sta. (Geneva), Bul. 329-433, 1911

"Shall the fruit grower manufacture his own lime-sulphur."
This is a simple problem in arithmetic for the individual grower

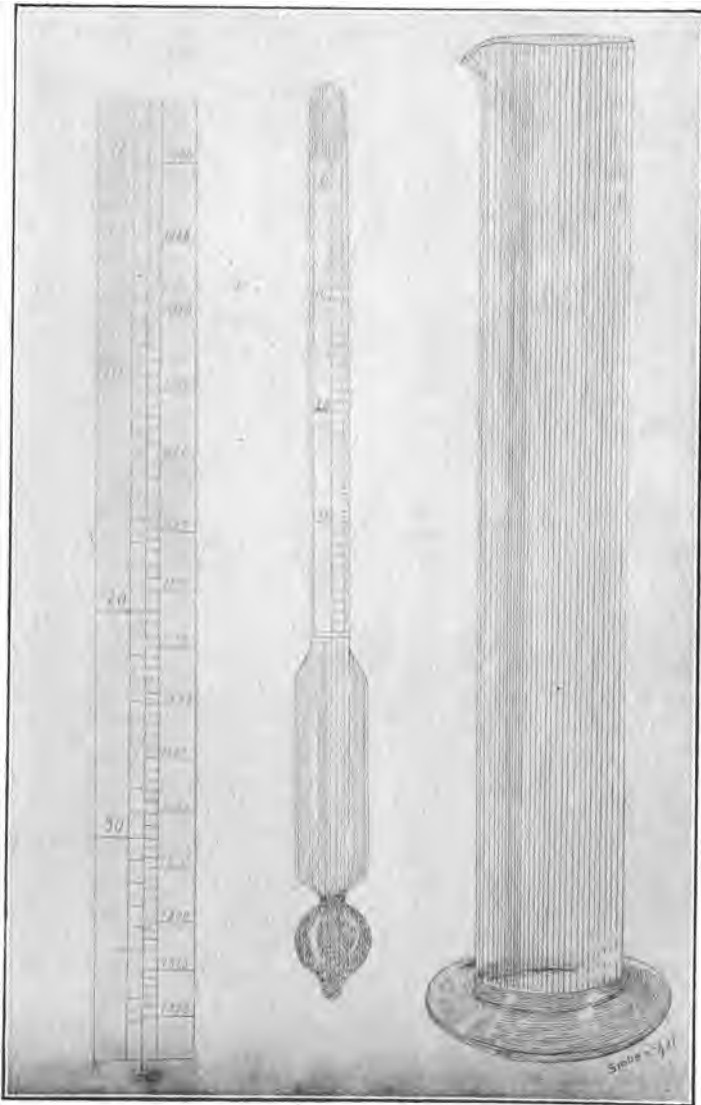


(From G. H. Lamson, Bul. 71, Conn. Exp. Sta.)

to solve for himself. His decision as to whether he should make his own or buy the commercially prepared product will depend

2-30051

upon the following factors: First, the cost of securing fresh stone lime with a guarantee from the producer that it contains at least



BEAUME—SPECIFIC GRAVITY HYDROMETER FOR TESTING LIME-SULPHUR.

(b) Shows the Double Scale. The right half is the Specific Gravity and the left is the Beaume Scale. (c) Shows strength for winter applications for San Jose Scale.

90% calcium oxide and not more than 5% magnesium oxide; second, the cost of commercial solution; third, the cost and efficiency

of labor; fourth, the cost of fuel for cooking and equipment, such as kettles, barrels or containers, and hydrometer; fifth, the comparison of the above factors with the price for which the commercial preparation may be obtained.

As a rule, the person having a small orchard or small number of trees will find it more economical to buy his lime-sulphur prepared. In several instances the commercial orchardist—in view of the foregoing factors—finds it is economical to buy the commercially prepared product as he is usually able to get a special price by buying in car load lots or in large quantities.

NO. 2. KEROSENE EMULSION:

This mixture is used in the summer control of scale insects while they are in the crawling stage. It is also used against plant lice and has been effectively used in the control of mites. The following is the formula and process of preparation:

| | |
|-----------------|---------------------|
| Soap | 1 pound |
| or | |
| Gold dust | $\frac{1}{2}$ pound |
| Water | 1 gallon |
| Kerosene | 2 gallons |

Dissolve soap in one gallon of soft water. Boil water to dissolve soap. When dissolved remove from the fire and add to 2 gallons kerosene. Stir vigorously until complete emulsion is made. It will then have a thick creamy appearance. When completed, test with a piece of glass by inserting it into the emulsion and then drawing it out and look for globules of unemulsified oil. If the oil is not completely emulsified it will injure the foliage. Dilute one part emulsion to from nine to fifteen parts of water according to tenderness of foliage and apply directly to insects.

NO. 3. NICOTINE SULPHATE SOLUTION (Black Leaf 40).

This is a proprietary insecticide and has proven to be very effective in the control of plant lice and mites. This is manufactured by the Kentucky Tobacco Products Company, Louisville, Kentucky. It should be diluted according to the directions on the package.

NO. 4. WHALE OIL SOAP:

This is used mostly against plant lice, mealy bugs and other soft-bodied insects.

| | |
|----------------------|-------------|
| Whale oil soap | 1 pound |
| Water | 6-7 gallons |

No. 5. TOBACCO TEA:

Tobacco stems or refuse from cigar

factory 1 pound

Water 1 gallon

Steep as in making tea, but do not boil since the nicotine which gives it an insecticidal value, is volatile and is lost to a great extent in boiling.

No. 6. SULPHUR:

Finely divided sulphur used as a dust or in connection with soap and lye has been found useful in controlling mites such as red spider. The following formula has been used with good results:

Sulphur 2 pounds

Soft soap 4 ounces

Water 4 gallons

No. 7. PYRETHRUM (Persian Insect Powder):

This is used against fleas, roaches, flies and mosquitoes. When used for the first two pests, it should be used in the powdered form, but in using it against flies and mosquitoes it should be burned to create a dense white smoke in the room. This stupifies the insects and they fall to the floor and may be swept up and burned while in a comatose condition.

No. 8. CREOLIN:

This is used as a wash on animals infested with fleas or mites. Use 2 to 3 tablespoonsful of creolin to one gallon of soap suds.

No. 9. POWDERED LIME:

This is often used in combatting rose slugs, pear slugs and other insects that have sticky bodies.

Stomach Poisons.

No. 1. ARSENATE OF LEAD:

Arsenate of lead may be purchased ready for use or may be prepared. On account of the technic of securing the proper constituents it is advisable to use the commercial product. Formula for preparing Arsenate of Lead:

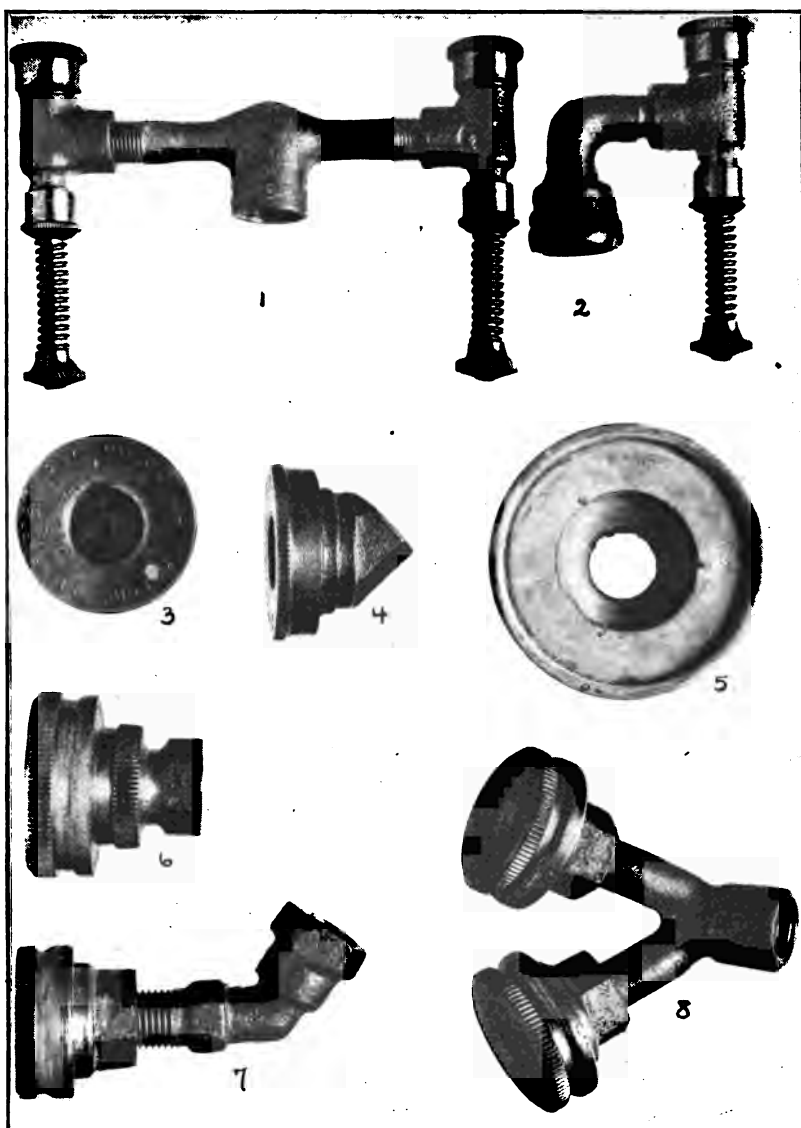
Arsenate of soda 20 ounces

Water 2 or 3 gallons

Acetate of lead 3½ pounds

Water 3 gallons

These two solutions are mixed and diluted to make 100 gallons.
Arsenate of lead has within recent years displaced Paris Green



SOME TYPES OF NOZZLES.

- | | |
|---------------------------------------|-------------------------------|
| (1) Double Vermorel. | (5) Drip Preventer. |
| (2) Single Vermorel. | (6) Side view of No. 3. |
| (3) Top view of Friend Type. | (7) Showing Angle Attachment. |
| (4) Side view of Friend Angle Nozzle. | (8) Double Angled Nozzle. |

to a very great extent on account of the former having so much greater adhering properties, which in most cases is desirable.

No. 2. PARIS GREEN:

This is a more drastic poison than arsenate of lead, but not so dangerous to use on fruits or vegetables that are ready for use, as this very easily washes off. When Paris Green is used in spraying plants with waxy foliage, such as cabbage, two pounds of soft soap should be used to every 50 gallons of solution to serve as a "stick-er." Paris Green makes a good insecticide when used at the strength of one-half pound to 50 gallons water. One pound of lime should be used to every one-half pound Paris Green for the purpose of neutralizing the free arsenic.

No. 3. ORTHO ARSENITE OF ZINC:

This is a poison that has recently come on the market and seems to be taking the place of both Paris Green and arsenate of lead throughout the West. The future of this insecticide seems very good as it is cheaper than either Paris Green or arsenate of lead. It is not advisable to attempt to prepare this without the knowledge of chemistry which is essential in getting the proper combination. It is used to about $1\frac{1}{2}$ pounds to 50 gallons water.

Repellants.

No. 1. NAPHTHALENE FLAKES:

This is used as a repellant against fleas, flies, clothes moths, "buffalo moths," museum pests, chiggers, etc. In the recent outbreak of fleas in the northern part of the city, the use of naphthalene flakes on rugs and carpets and upon the infested floors proved very effective.

No. 2. TREE TANGLEFOOT:

This is a trade name of a sticky substance manufactured by O. & W. Thum Co., Grand Rapids, Michigan. It is used for banding trees to catch such insects as the wingless females of the tussock moth and canker worms, moths and various caterpillars that migrate from tree to tree.

No. 3. CRUDE CARBOLIC SOAP PAINT:

This is made by the following formula:

Crude carbolie acid..... 1 pint
Thick soap paste..... 10 gallons

It is used as a repellant against fruit tree bark beetle, round-headed and flat-headed apple borer and peach tree borer.



**A GOOD TYPE OF BARREL SPRAY OUTFIT, SHOWING HOSE, EXTENSION
RODS AND NOZZLES.**

Fumigants.

No. 1. CARBON BISULPHIDE:

This material is used against household and granary insects where a gas that is heavier than air can be used to advantage. It is a clear and highly volatile liquid with a very disagreeable odor. The gas is slightly poisonous to man, but aside from producing dizziness and headache has no other serious effects. To fumigate grain or household goods it is usually poured directly upon them and if the chemically pure product is used it leaves no stain. If it is impossible to obtain chemically pure material place it in pans to evaporate. Use from one-half to one pound of liquid to every 25 square feet of floor space to be fumigated. The liquid should be distributed into several pans. Rooms to be fumigated should be tightly closed and kept at a temperature of 60 to 72 degrees Fahrenheit. Household goods may be placed in tight boxes and fumigated. **CAUTION**—Great care must be exercised to keep flames away as the gas is highly explosive.

No. 2. HYDROCYANIC ACID GAS:

This fumigant is one of the deadliest poisons known and while used for fumigating nursery stock, flour mills, factories, green-houses, etc., it must be handled with utmost care. It is as dangerous to human life as to insect life. It is produced by placing cyanide of potassium in sulphuric acid and water.

For every 100 cubic feet of space to be fumigated the following amount of material should be used.

| | |
|---------------------------|----------|
| Water | 4 ounces |
| Sulphuric acid | 2 ounces |
| Cyanide of potassium..... | 1 ounce |

Place the water in a stone or earthen dish and pour acid into the water. Place cyanide of potassium in a paper bag and drop it into the dish and immediately get out and close the door tightly. An arrangement should be made for opening the doors and windows from the outside without getting close. This may be done by having some sort of a string arrangement whereby they may be opened from a distance. The gas should remain within the enclosure for about twelve hours and the enclosure should be opened about three or four hours before man should enter.

No. 3. SULPHUR DIOXIDE:

This is produced by burning sulphur. It is not a very successful fumigant against insect life. It has been recommended that 2 pounds to every 1,000 cubic feet of space should be used for bedbugs, etc., but in our work in the eradication of dog fleas 4 pounds to every 1,000 cubic feet gave very poor results.

No. 4. TOBACCO:

This is used most extensively as a fumigant in green houses in combatting plant lice; but outside of this use it is of little value.

FUNGICIDES.

No. 1. *BORDEAUX MIXTURE:

"Bordeaux mixture is the standard fungicide for most of the diseases injurious to orchard and garden crops. It is made from copper sulphate and lime, and was introduced into this country from Europe in 1887 by the U. S. Department of Agriculture. The original formula has been modified somewhat, and the mixture giving the best results today is made from:

4 pounds of copper sulfate
4 pounds of lime
50 gallons of water

SMALL QUANTITIES.

"When the small home orchard composed of only a few trees is to be sprayed, the equipment should consist of a 50-gallon barrel, two tubs of at least 25 gallons capacity, two buckets and a paddle. Arrange the tubs so that one is on either side of the barrel. Place in one of the tubs 25 gallons of water, and dissolve in it 4 pounds of copper sulfate by suspending it in a coarse sack just below the surface of the water. About one hour should be allowed for this; but if hot water is available, the copper sulfate can be dissolved in quantity in much less time, and then diluted to 25 gallons with cold water. In the other tub carefully slake 4 pounds of stone lime, using only sufficient (hot) water to have the lime, when thoroughly slaked, in the form of a thick paste, in which form it should be allowed to cool. When cold, dilute to 25 gallons. The copper sulfate and milk of lime are now ready to mix, two persons being necessary for the operation. Have the contents of each tub well stirred; then pour a bucket of each simultaneously into the barrel, allowing the two streams to come together. Continue in the same way until the entire amount is made. Thoroughly agitate the blue mixture in the barrel, and transfer it through a strainer into the spray tank. It is now ready for application.

LARGE QUANTITIES.

"In preparing Bordeaux mixture for use in the large commercial orchard, where spraying is done from one or more 200-gallon tanks, it is customary to make up stock solutions of copper

* From O. S. Watkins, Ills. Agricultural Experiment Station, Circular No. 160.

sulfate and lime. This is to avoid delays occasioned by slaking each batch of lime, and dissolving each lot of copper sulfate.

"Slaking the Lime.—One of the most important steps in the preparation of Bordeaux mixture is the slaking of the lime, and care must be taken to have this properly done. At least a day before the spraying operations are to begin, slake one or more batches of lime of 50 pounds each by placing the lime in a slaking box or barrel, together with 7 or 8 gallons of water, which is a sufficient quantity to start the action. As soon as the lime begins to slake, it should be continually stirred. More water should be added as needed from time to time to prevent the development of too much heat and consequent "burning" of the lime. When too small amount of water is used, the lime crumbles to a powder, with the result that there are many small lumps that do not completely slake. On the other hand, too much water should also be avoided, for this likewise causes incomplete slaking and therefore a reduction in the actual amount of lime added to the mixture. Lime, during the process of slaking, should have constant attention, adding only a small quantity of water at a time, so as to keep the action even and insure the lime being perfectly slaked.

"When the lime is completely slaked it should be a rather thick paste, in which form it should be allowed to cool. In slaking lime to be used in the preparation of Bordeaux mixture the paste mass should never be cooled artificially, for if this is done the action is not completed. When the slaked lime is cold, transfer to the stock solution barrel, if a slaking box has been used, and add sufficient water to bring the total volume in the barrel to 50 gallons. This is termed a stock solution and when well mixed each gallon contains 1 pound of lime.

"Copper Sulfate Solution.—To prepare the stock solution of copper sulfate, suspend 50 pounds of the blue stone in a burlap sack near the top of a 50-gallon barrel nearly filled with water. Several hours should be allowed for solution to take place. When all of the sulfate is dissolved, bring the total volume in the barrel to 50 gallons. When well mixed each gallon contains 1 pound of copper sulphate.

"As several days ordinarily elapse between the different applications in order to keep the stock solutions at their original strengths the volumes of the material in each of the stock solution barrels should be noted at the completion of each application, and before any more Bordeaux mixture is made, water should be added to replace that which has been lost by evaporation.

“*Making the Mixture.*—There are two methods by which Bordeaux mixture can be made in large quantities: One in which an elevated platform is used, and the water pumped by hand; and another in which no elevated platform is necessary, but all solutions are pumped by means of a tank filler.

“(1) *With Aid of Elevated Platform.*—For the making of large quantities of Bordeaux mixture certain equipment is necessary which will help diminish the labor and avoid waste of time. An elevated platform situated near the water supply is an essential feature. This platform should have two parts, one higher than the other. On the lower part is supported a mixing tank, which has a capacity equal to that of the spray tank, at such distance above the ground as will allow the delivery of the mixture by gravity to the top of the spray tank driven underneath. On the upper platform there should be two diluting tubs, each of a capacity of at least 100 gallons, several barrels in which the stock solutions of copper sulfate and lime may be kept, and sufficient room for the operator. This upper platform should be at such a height that the two diluting tubs can be adjusted to deliver the solutions together through a strainer into the mixing tank.

“The necessary equipment provided, and the stock solutions prepared, to make 200 gallons of Bordeaux mixture, using the 4-4-50 formula, which calls for 4 pounds of copper sulfate, 4 pounds lime and 50 gallons of water, proceed as follows: Measure into one of the diluting tubs 16 gallons of the stock solution of copper sulfate; then add 84 gallons of water. In the other tub, place 16 gallons of the well mixed stock solution of lime, and add water to make 100 gallons of diluted lime. There are now 100 gallons each of copper sulfate solution and milk of lime. In mixing, equal streams from each tub should be conducted directly into the strainer supported over the mixing tank. The milk of lime should be stirred continually, so as to have a homogeneous mixture at all times coming in contact with the copper sulfate solution.

“(2) *Using the Tank Filler.*—During the last two or three years manufacturers of spraying machinery have introduced a very convenient device called a tank filler, by use of which all the water used in making spraying preparations can be pumped by the gasoline engine. To make 200 gallons of Bordeaux mixture, using the 4-4-50 formula, the following procedure is used: Transfer through a strainer 16 gallons of the well mixed stock solution of lime into the spray tank; then add 84 gallons of water to bring the total

volume of the diluted lime to 100 gallons. Next put 16 gallons of the stock solution of copper sulfate into a 100-gallon tub, which may be stationed on the ground, and add water to bring total volume of copper sulfate solution to 100 gallons. Thoroughly mix the copper sulfate and water, and with the agitator in the spray tank working throughout the entire process, gradually introduce through the strainer into the spray tank the copper sulfate solution. The resulting mixture is now ready for use."



BORDEAUX INJURY ON APPLE. (Third Annual Report.)

No. 2. LIME SULPHUR:

Both home boiled and commercial (See Insecticides).

No. 3. SELF-BOILED LIME-SULPHUR:

This fungicide has become famous in the control of brown rot in stone fruits. It is especially valuable as a fungicide on peaches on account of its non-injurious effects to the foliage.

Formula—

8 pounds stone lime.
8 pounds sulphur.
50 gallons water.

This mixture can be made in any quantity desired by using materials in proportion to the above formula. Messrs. Scott and Ayers, in Bulletin 174 Bureau of Plant Industry, U. S. Department of Agriculture, give the following method of preparing self-boiled lime-sulphur.

"The lime should be placed in a barrel and enough water poured on to almost cover it. As soon as the lime begins to slake, the sulfur should be added after first running it through a sieve to break up the lumps. The mixture should be constantly stirred and more water added as needed to form a thick paste at first, and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as it is well slaked, water should be added to cool the mixture and prevent further cooking. It is then ready to be strained into the spray tank, diluted and applied.

The stage at which cold water should be poured on to stop the cooking varies with different limes. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking and care must be taken not to allow the boiling to proceed too far. If the mixture is allowed to remain hot fifteen or twenty minutes after the slaking is completed, the sulfur goes into solution, combining with the lime to form sulfids, which are injurious to peach foliage. It is very important, especially with hot lime, to cool the mixture quickly by adding a few buckets of water as soon as the lumps of lime have slaked down. The intense heat, violent boiling, and constant stirring result in a uniform mixture of finely divided sulphur and lime, with only a very small percentage of the sulfur in solution. The mixture should be strained to take out the coarse particles of lime, but the sulfur should be carefully worked through the strainer."

No. 4. AMMONIACAL COPPER CARBONATE:

This material is designed principally for use on fruit that is nearly ripe or on ornamental plants, as it does not leave discolorations which are in the above instances objectionable.

Formula—

Copper carbonate, 5 ounces.

Strong ammonia (26° Beaume), 3 pints.

Water, 50 gallons.

Use a wooden pail for making a thick paste by adding water to copper carbonate. Dilute the ammonia with three or four parts of

water, add to the copper carbonate paste and stir well. Add enough water to bring the quantity up to 50 gallons of mixture.

Combination Spray Mixtures.

For summer spraying there are nearly always fungous troubles to fight at the same time insect pests must be combated, and it is therefore very economic to combine an insecticide with a fungicide. On account of chemical reactions there are several combinations that should not be attempted.

According to Prof. R. A. Cooley and Deane B. Swingle of Montana, tobacco extracts may safely be mixed with any arsenical poisons. Lime-sulphur, however, should not be mixed with any, except arsenate of lead; but Bordeaux mixture may be used in conjunction with arsenate of lead, Paris Green and arsenite of lime.

Wound Dressings.

To prevent evaporation and also protect the wound from germs of decay it should be treated with a dressing. Ideal wound dressings should therefore possess at least three characteristics. In the first place they should be of a material that will prevent decay from entering the wound; second, they should be of a nature that will not injure the living tissue upon which they are applied; and third, their cost should be within the bounds of reason.

No. 1. WHITE LEAD PAINT:

This is perhaps the most economic and convenient form of wound dressing. White lead should be mixed with raw linseed oil to make a thick heavy paste that can be applied with a brush or swab. The wounds should be dry when it is applied and the paint should be well worked into the grain of the wood. Lamp black may be added to the paint to bring its color about the same as that of the bark.

No. 2. GRAFTING WAX:

This material used as a wound dressing is very good and may be applied to cut surfaces, graft-unions or wounds of any sort. The main objection to grafting wax as a wound dressing is the price. For graft-unions, however, it is almost necessary. The following material is used in making it.

| | |
|----------------------|----------|
| Resin | 4 pounds |
| Beeswax | 2 pounds |
| Rendered tallow..... | 1 pound |

The following is the method of procedure in making grafting wax: Melt the resin and beeswax over a slow fire but do not boil it. Add the tallow and as soon as all is melted pour the entire mass into a bucket of cold water. Flatten out the whole mass with greased hands in order that it may cool uniformly. As soon as cool enough to handle take it from the bucket and work or pull it as one would in making taffy. The longer it is pulled, the better will be the quality. When completed, place in a cool location and use as desired. It will keep indefinitely. It is advisable to have a bucket of warm water at hand when it is used in cool weather to warm it up and make it more pliable. If used on wounds it will probably have to be replaced the second year, as the wax will become loosened.

No. 3. COAL TAR:

This material should be used sparingly on any kind of a tree and on account of the great danger of injury to the living tissue, it is not advisable to attempt its use upon any except shade and ornamental trees.

Ordinary tar may be used to prevent bleeding in vines if powdered slate or some other substance similar to it be added to the tar. One part of tar should be used with four parts of powdered slate.

Asphaltum or mineral pitch with a high melting point has been used with very good results in several parts of the country and the future of this material as a wound dressing is promising. Where a small number of wounds are to be treated, however, it would not be practical to invest in equipment necessary for melting this material.

SPRAY CALENDARS.

The following is a general spray schedule for apple. Since the conditions vary so greatly from the northern to the southern extremities of the State, it will in some instances be advisable to change the treatment to meet the existing conditions. This statement applies also to the other spray calendars in this report. They are, however, arranged to cover conditions in a general way throughout the State.

Spray Calendar For Apple.

| When to Spray. | For what to Spray. | Material to Use. | Remarks. |
|---|--|--|---|
| WINTER OR DORMANT SPRAY. In bad cases of scale infestation, it is advisable to spray both in fall and spring while trees are dormant. | San Jose, Scurfy, Oyster Shell and other scale insects. | Lime Sulphur diluted according to table on page 16. | This application is also valuable in killing fungous spores that pass the winter on the bud scales and other parts of the tree. It also cleans off the shaggy bark and thus destroys hibernating places for the codling moth and other insects. |
| FIRST SUMMER SPRAY. When the blossom buds show, but before the petals open. | Scab, Curculio, Bud Moth, Canker Worm, Cigar Case Bearer. etc. | Lime Sulphur, (See dilution table for Summer Spray), 2½ lbs. arsenate of lead. | This is an important spray for scab and should be done very thoroughly. Where curculio and other insects are not bad, 2 lbs. arsenate of lead will be enough. |
| SECOND SUMMER SPRAY. Immediately following the dropping of the petals. | Codling Moth, Curculio, Scab, Leaf Spot, Cedar Rust and various leaf eating insects. | Lime Sulphur, same as for first summer spray. 2½ lbs. arsenate of lead. | When a large number of trees are to be sprayed, it is advisable to begin when about 90% of the petals have fallen so that it may be completed before the calyx lobes close. |

SPRAY CALENDAR FOR APPLE—Continued.

| When to Spray. | For What to Spray. | Material to Use. | Remarks. |
|--|---|---|---|
| THIRD SUMMER SPRAY. Where no apple blotch exists. About two weeks following No. 2. | Leaf Spot, Scab, Codling Moth, Cedar Rust, Curculio. | Same as above. | When apple blotch exists, the following third summer spray should be applied. |
| THIRD SUMMER SPRAY. Where blotch exists. About three weeks after No. 2. | Blotch Leaf Spot, Scab, Codling Moth, Cedar Rust, Curculio. | Bordeaux mixture 4-4-50. 2 lbs. arsenate lead. | In slight infestations of blotch and if the weather has not been unusually moist and warm, lime - sulphur as above will control it. Otherwise Bordeaux will be necessary to control it. |
| FOURTH SUMMER SPRAY. The last week in June or the first week in July, depending on the latitude. | Second brood of Codling Moth, Bitter Rot, Blotch, Sooty Blotch and Fly Speck. | Lime sulphur and arsenate of lead as in No. 2 or Bordeaux and arsenate of lead as for blotch (No. 3). | When Bitter Rot or Blotch exists, Bordeaux should be used instead of lime sulphur. |

A fifth and sixth application when Bitter Rot is troublesome should follow the fourth summer spray and should be made from two to three weeks apart.

Spray Calendar for Pear and Quince.

The spray calendar for pears and quinces is practically the same as for apples. Aside from the fact that pears are not subject to Bitter Rot and Blotch. Pears are susceptible to the attacks of Pear Slug, the remedy for which is discussed in connection with a description of this insect.

Spray Calendar for Cherries and Plums.

| When to Spray. | For What to Spray. | Material to Use. | Remarks. |
|-----------------------|----------------------------|---|--|
| DORMANT SPRAY. | San Jose and Cherry Scale. | Lime sulphur. See apple spray calendar. | Plums are very susceptible to the attack of San Jose Scale, but cherries, especially the sour varieties, are seldom troubled. Cherry Scale is sometimes serious. |

SPRAY CALENDAR FOR CHERRIES AND PLUMS—Continued.

| When to Spray. | For What to Spray. | Material to Use. | Remarks. |
|---|---|--|---|
| FIRST SUMMER SPRAY. When the blossom buds show, but before the petals open. | Plum Curculio and other leaf eating insects, Brown Rot, Shot-hole Fungus, Mildew. | Bordeaux 4-4-50, or lime sulphur, 2½ lbs. arsenate of lead to 50 gallons solution. | When lime - sulphur is used on plum and cherry, 1 gallon of concentrate solution that will test 32 deg. Beaume should be diluted with from 50 to 60 gallons water. Self-boiled lime-sulphur may be substituted for the cooked in controlling Brown Rot. Bordeaux should be slightly weaker for plums of the Japanese variety. |
| SECOND SUMMER SPRAY. Immediately after the bloom drops. | Plum Curculio, Brown Rot, Shot-hole Fungus, Slug. | Same as No. 1. | This is a very important spray for Curculio and Shot-hole Fungus. |
| THIRD SUMMER SPRAY. About two weeks after No. 2. | Brown Rot, Shot-hole Fungus. | Same as No. 1 and No. 2 except Ammoniacal Copper Carbonate should be substituted for Bordeaux on cherries. | As Bordeaux will show on the ripened cherries, it is replaced by Amm. Cop. Carb. for this spray. |
| FOURTH SUMMER SPRAY. During the latter part of June. | Brown Rot of Plum, Shot-hole Fungus and leaf eating insects. | Same as No. 1 and No. 2. | To protect the foliage of the cherry, it is sometimes advisable to spray after the fruit is gathered. |
| FIFTH SUMMER SPRAY. For plums, soon before the fruit begins to ripen. | Same as above. | Same as No. 1 or 2 except that Amm. Cop. Carb. should be substituted for Bordeaux mixture. | Bordeaux used for this spray would show on the ripened fruit and should be displaced by Amm. Cop. Carb. |

Spray Calendar for Grapes.

| When to Spray. | For What to Spray. | Material to Use. | Remarks. |
|--|---|--|---|
| DORMANT SPRAY. | San Jose or Grape Scale. | Lime-sulphur, winter strength. | Grapes are occasionally found infested with San Jose Scale, but more often with Grape Scale. |
| FIRST SUMMER SPRAY. Soon after the first leaves begin to open. | Downy and Powdery Mildew, Black Rot, Flea Beetle. | Bordeaux 4-50. 4 lbs. arsenate of lead to 50 gallons solution. Soap sticker. | If no flea beetles are present the arsenate of lead may be omitted from this spray. |
| SECOND SUMMER SPRAY. Just before blooming. | Mildews, Black Rot, Berry Moth, Rose Chafer, Curculio, etc. | Bordeaux 4-50, 3 lbs. arsenate lead. Soap sticker. | |
| THIRD SUMMER SPRAY. Immediately after fruit sets. | Same as second. | Same as second. | In small vineyards it is advisable to sack the grapes immediately following this spray and subsequent sprays may be abandoned if no insects or diseases are damaging the foliage. |
| FOURTH SUMMER SPRAY. About 15 days after third. | Same as third. | Same as third. | These two sprays are primarily for the control of Black Rot and other diseases and insects will be controlled incidentally. |
| FIFTH SUMMER SPRAY. About 15 days after fourth. | Same as fourth. | Same as fourth. | |

NOTE—When the nymphs of the grape leaf-hopper appear, control measures as recommended under the description of this insect should be followed.



A BOUNTIFUL CROP.

This is a typical view from the orchard of John Hollingsworth, of New Augusta, Indiana. This orchard, which has been badly infested, presents a striking example of complete eradication of San Jose Scale by the use of Lime-Sulphur.

GENERAL REMARKS ON INSECTS.

The whole group of insects so far as agriculturists are concerned may be in a general way classified according to the methods that must be employed for combating them. It is evident that any insect, whether in the larval or adult stage that feeds upon the surface of the plant by devouring the plant's tissue must be controlled by an arsenical poison. The leading insecticides of this class are lead arsenate and Paris Green. This group may be illustrated by the leaf-eating caterpillars, the potato beetle, codling moth, and any other insect that feeds upon that portion of the plant that can be reached by a spray solution.

Another group of insects is illustrated by the plant lice, scale insects, squash bugs, and in fact any insect that obtains its food by sucking the juice from beneath the surface of the plant. It is obvious that a stomach poison applied to the surface would not be effective in controlling pests of this sort. Some insecticide, therefore, that will kill the insect by coming in contact with its body is necessary for a pest of this sort. The scale insects can best be controlled by a winter spray with a strong solution of lime-sulphur, miscible oils, and a number of other proprietary mixtures designed especially for controlling scale insects. Lime-sulphur solution, however, has proved to be the most efficient and economical as a scalecide. Another phase of sucking insects is met with in those insects such as plant lice that feed upon the foliage or the tender shoots of plants. These, of course, require a contact insecticide; but one is confronted by a most serious problem when he attempts to apply contact insecticides that will not injure the foliage. Nicotine solution and kerosene emulsion have produced very good results and are what might be called summer contact insecticides.

The above describes in a general way the factors to be considered in spraying for insect troubles. There are some insects, however, where methods other than spraying may be more practicable. Preventative measures by destroying or removing the harboring places where the insects may pass the winter will greatly reduce the numbers. Hand picking, although tedious work, is often practiced with very good results. The methods to be employed will in nearly all cases depend upon the extent of infestation, as well as the nature of the insect causing the trouble.

There are certain definite lines along which the farmer should work in handling insect problems. The best advice that one can give is that he should by all means keep his eyes open. Close examination for the beginning of infestation is very essential, as at this time only a very little work may be necessary to check what would otherwise be a serious infestation resulting in considerable loss. There seems to be an inclination on the part of the average person not to recognize any danger until the plants or trees begin to die. At this point an investigation is made, only to find that the infestation is so severe that the chance of saving the lives of the plants is small. One should familiarize himself with the most destructive pests in his particular section of the State and also keep a vigilant outlook for destructive insects that have not yet reached him.

The foregoing general instructions for combating insects may be sufficient even though the particular insect doing the damage is not definitely identified. It is advisable, however, that one should take advantage of the State departments as well as the United States Department of Agriculture for identification and methods of controlling injurious insects.

It is important when one sends insects for identification that as complete data regarding the extent of infestation, the host plants upon which they are working, date of occurrence, and any other information possible should be sent along with the insect and a specimen of the damage done. This office will be pleased to give prompt attention to matters of this sort.

In the following pages there will be no attempt at a systematic classification of insects. The discussion of each form is made as brief as possible, but at the same time characteristics are given sufficient to enable the unscientific person to recognize it. The order in which the various insects are taken up does not conform with any entomological system of classification, but is arranged according to the host plants upon which they do the greatest damage.



TREE BADLY CRUSTED WITH SAN JOSE SCALE.

Note the ashy-gray appearance. (First Annual Report.)

SAN JOSE SCALE.

Aspidiotus perniciosus—Comst.

This insect is, without doubt, the most serious orchard pest in Indiana. Its distribution in a general way covers the entire State. There are locations, however, where the scale has not yet established itself, but it seems to be only a question of a few years until it will be established in every community where fruit trees are allowed to go unsprayed. Thousands of fruit trees have been killed during the past year by this pest and to the casual observer it would seem that the fruit-growing industry in the State is greatly endangered by its presence. This pest, however, is not looked upon as being so serious by those who have employed proper methods for controlling it.

When allowed to develop undisturbed it will kill young trees in from two to three years. Older trees will struggle along for several years but will be materially weakened. With a severe winter such as the one just passed, coupled with this weakened condition caused by severe scale infestation, the death of thousands of apple and other fruit trees has resulted. San Jose scale has wrought so much damage on account of the average farmer not being able to recognize it. The insect is so small that the person not acquainted with its presence will not realize that there is anything wrong with his trees until they begin to die. In a great many instances, the trees are too far gone to be successfully brought back to a normal state of health. San Jose scale has become so thoroughly spread over the country, not through its own efforts, or by the influence of natural agencies, but more through the shipment of infested nursery stock. The mistake of not having thorough inspection of nurseries in the different States is largely responsible for its wide spread. It is easy to see this mistake after the damage is done, and the advent of the spread of San Jose scale in this country has resulted in more stringent inspection laws in a great many States.

There is no doubt about the effect that these laws have accomplished in preventing a wide distribution of the Brown Tail and Gypsy Moths as well as other insects and diseases that are likely to be carried on nursery stock. By proper vigilance the spread of San Jose scale over the country could have been prevented. When the scale is once established in a community and is allowed to spread uninterrupted it will soon show its effects upon the fruit trees. It is known to spread short distances upon such agencies as wind, birds, large insects, men and teams working among infested trees,

and larger animals, such as hogs, that rub against infested trees and carry it to uninfested places.

San Jose scale is not such a serious problem with the person



APPLE TREES BUTCHERED FOR THE PURPOSE OF CONTROLLING SAN JOSE SCALE.

It is not necessary to prune trees as severe as this to control scale. (Original.)

who will acquaint himself with the proper methods for combating it. A great number of materials have been experimented with and none of the present surpass lime-sulphur solution as a practical



SAN JOSE SCALE.

Female with young scales. Greatly enlarged. (Fourth Annual Report.)

remedy for this purpose. A more complete discussion of lime-sulphur is given on another page of this report.

Larva.—The larvæ are minute, almost microscopic in size with a long whip-like mouth piece and with two long waxen threads on the last segment of the body. They are yellow in color and resemble tiny mites crawling about over the twigs. The young are born alive after which they lie curled up lifeless for several hours, crawling about from one to three days and then settling down and begin sucking their food material from the plant. As soon as they station themselves, a waxy secretion forms a covering which melts together producing a scale. This covering is circular in the female and elongated in the male. The larval stage lasts from ten to twelve days.

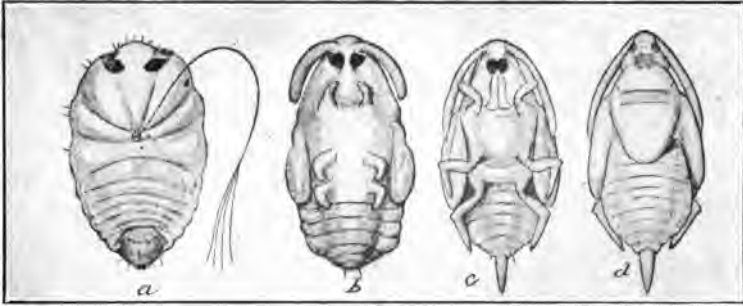
The second period in the development of the scale is the one where the male becomes distinguishable from the female. The female loses legs, eyes, and antennæ and resembles a pale yellow sac with well developed mouth parts which are very similar to the full developed insect.

The third period is the one in which the adult stage is reached. The complete development in the case of the female is reached about thirty days after birth. Each female insect is covered with a small circular scale of a grayish to almost black color. Concentric circles with a convex center forming a nipple which has a yellowish and shiny appearance, when rubbed, characterizes the adult female scale. When the covering is removed a small soft yellow mass may be seen with the unaided eye. This is the insect proper. The head, legs, and eyes are lacking, and only the long thread-like mouth-piece and the anal plate (Pygidium) are seen. At each molt in the process of development the skin separates around the edge of the body; the upper half clinging to the covering and the lower part forming a sort of ventral scale. This is the usual manner of molting with this kind of insect.

The trunk and branches covered by San Jose scale have a rather rough, ashy-gray appearance. On slightly infested trees the insect may be detected by a red discoloration on the new growth surrounding the feeding place of the insect. This discoloration is supposed to be due to a poisoning of the tissues. The larvæ of the following generation make their appearance from thirty-five to forty days after the birth of the parent. The number of generations is very irregular; during the same season as many as five have been recorded. It is estimated that the progeny of a

female scale insect would reach a total of three billion, two hundred sixteen million, eighty thousand and four hundred in one year.

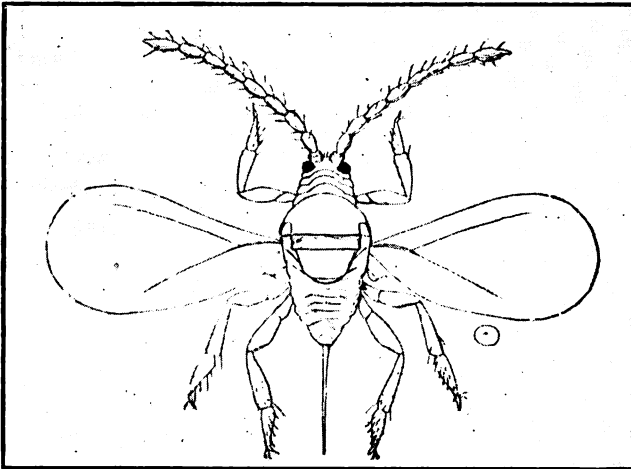
The second period of development of the male scale shows the insect to be larger than the female with comparatively large purple eyes (note above that the female loses her eyes during this period



THE DEVELOPMENT OF THE MALE SAN JOSE SCALE.

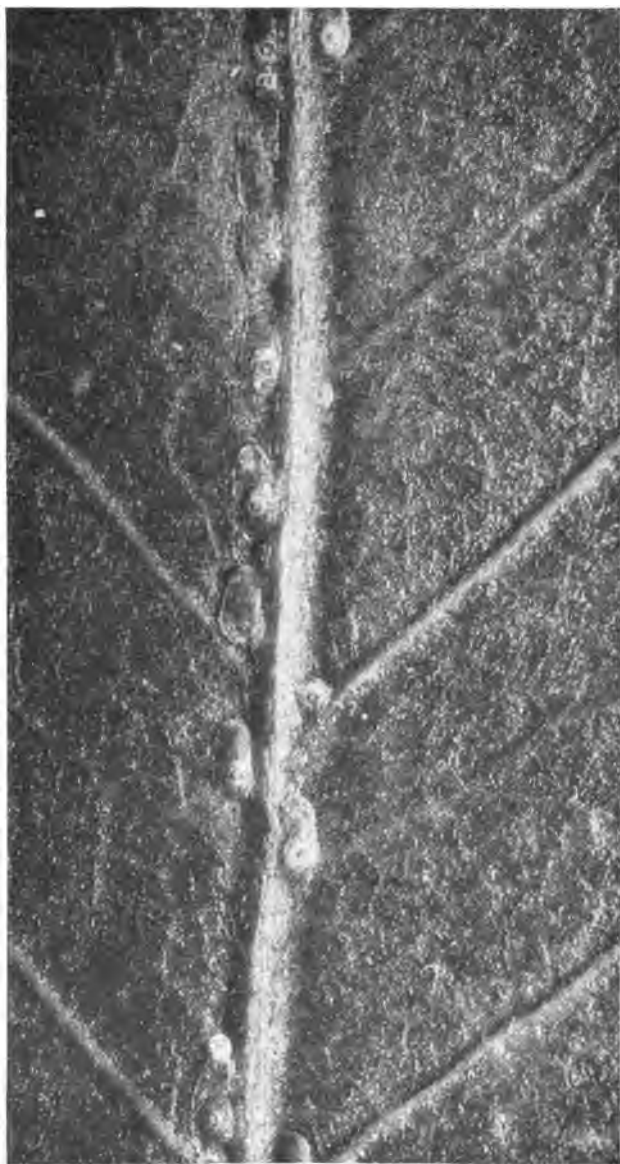
a) Ventral view of larva after first molt. (b) Same after second molt—propupa stage. (c and d). True pupa—ventral and dorsal views. All greatly enlarged. (After Howard and Marlatt, U. S. Dept. of Agr.)

of development). The legs and antennæ disappear in both sexes in the second period of development (instar). The males become elongated while the females are circular. This stage with the male lasts six days.



THE MALE OF SAN JOSE SCALE.

Greatly magnified. (After Howard and Marlatt, U. S. Dept. of Agr.)



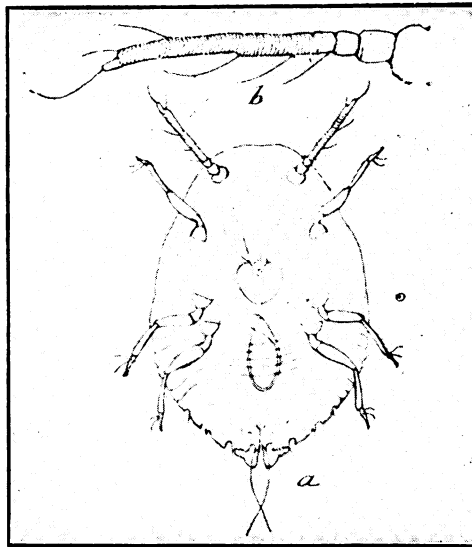
THE SAN JOSE SCALE.

Male scales greatly enlarged. (Fourth Annual Report.)

Eighteen days after birth the males change to the prepupa condition and the scale cover assumes an elongated, oval, slightly curved shape. The insect itself in this stage has a pale yellow color and has legs, antennæ and dark purple eyes. The true pupa stage is reached twenty days after birth, and the insect is of a pale yellow or purplish color with a distinguishable head, antennæ, legs, wing pads and style.

The adult males are small fly-like insects which reach full development from twenty-four to twenty-six days after birth. They issue from the pupa stage principally at night or during the evening. The feelers are well developed and the body is of an orange color with a darker head. The eyes are purple. Antennæ, legs and style are of a smoky tinge, and the wings are of an iridescent color and faintly cloudy. The adult male insect has mouth parts that are rudimentary, and is incapable of taking food.

The insects that are about one-half grown under their protecting cover are the ones that survive the winter. They become full grown



THE LARVA OF THE SAN JOSE SCALE.

(a) Very highly magnified. (b) Antenna of same.
(After Howard and Marlatt, U. S. Dept. of Agr.)

in the latter part of April or the first of May, at which time the males emerge and fertilize the females.

Hosrs: The host plants upon which the San Jose scale does

the greatest amount of damage belong to the Family Rosaceae—which includes all common deciduous fruits. Sanderson gives the



THE PUTNAM SCALE. (Enlarged)

Note the resemblance to San Jose Scale. (Fourth Annual Report.)

following order based upon the susceptibility to injury: first peach, second pear, third Japanese plum, fourth apple, fifth

quince. Cherry, especially the sour varieties, and the European plum are less injured.

REMEDIES: There has been no real effective summer spray for this insect which will not injure the trees. Ten to 15 per cent. kerosene emulsion, dilute lime sulphur, and whale oil soap (one pound to 5 gallons of water) have been used for summer spraying, but none have resulted in a satisfactory control of the pest.

Dormant spraying with concentrated lime-sulphur has proved itself to be the most effective remedy. Both fall and spring spraying is recommended where infestation is severe. Spray in the spring before the buds open where the infestation is slight. In cases where oyster shell and scurfy scales are found fall spraying is advisable as it helps to control these pests by injuring the scale cover and subjecting the eggs to snow, frost, etc. Forbes scale and Putnam scale are also controlled by the San Jose treatment.

CODLING MOTH.

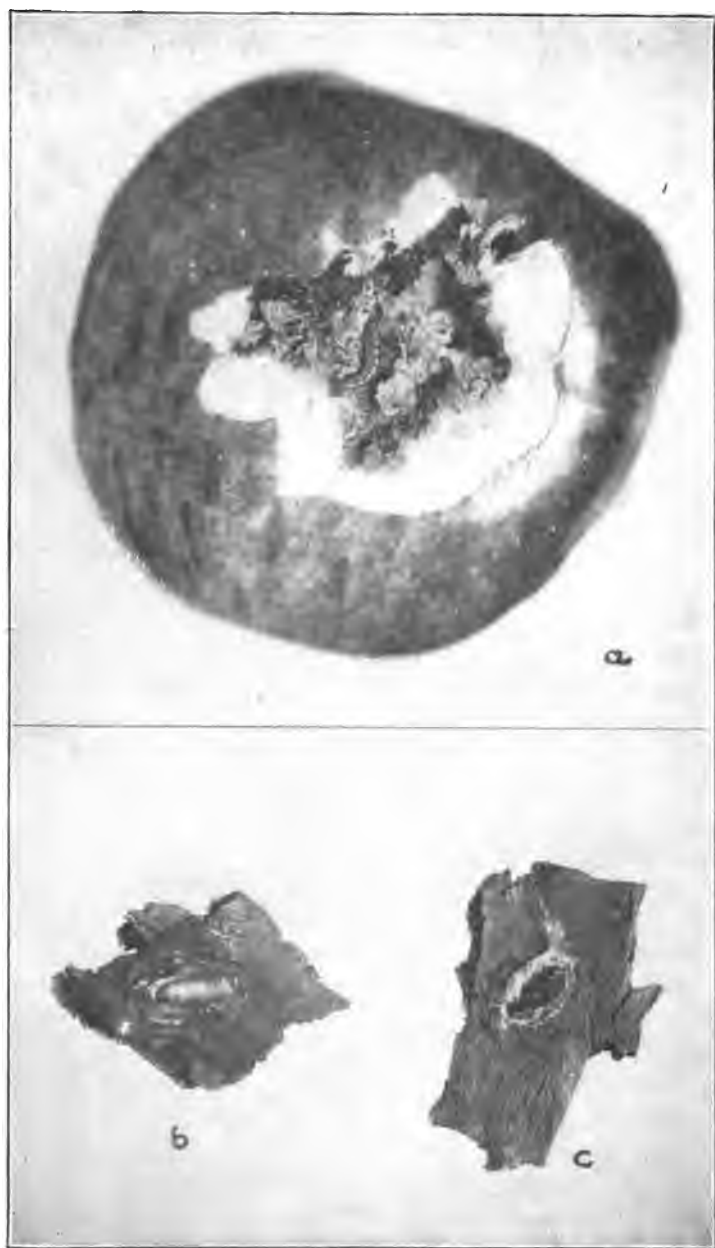
Cydia pomonella—Linn.

The larval form of the codling moth is the best known and perhaps the most generally destructive apple insect in the country. Wormy apples are found all over Indiana where the fruit trees are unsprayed or improperly sprayed. Quaintance estimates the annual loss in the United States caused by this pest at \$12,000,000.

EGG: The eggs are usually laid singly on the leaves near the fruit. One female moth lays from 60 to 75 eggs. The individual egg resembles a tiny white speck about the size of a small pin head. Immediately after having been laid they are transparent, but gradually turn to a brownish and finally to a black as the young caterpillar develops within. They hatch from five to ten days after having been laid, depending upon the temperature.

LARVA: The larvæ of the codling moth are the best known stage. The person who has not had the experience of eating wormy apples has never eaten very many. The young caterpillars are about 1/16 inch in length, with a whitish colored body and a shining black head.

There are blackish tubercles on the body which later become quite indistinct. The larvæ reach their development from twenty-one to twenty-eight days after hatching. When fully developed they are whitish in color with black heads and inconspicuous tu-



THE CODLING MOTH.

- (a) Work of caterpillar just beneath the skin of fruit. (b) Larva hibernating under bark.
(c) Pupa underneath bark. (Original. After Third Annual Report.)

bercles. They have three pairs of thoracic legs and five pairs of prolegs on the abdomen.

When full grown the larvæ are from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch in length. Immediately after emerging they feed on the young leaves and gradually make their way to the fruit. A large majority of the first brood enter the blossom ends. A few, however, enter the side of the apple where it has touched another apple or has been rubbed by a leaf. Upon entrance into the apple, they eat their way through to the seeds which seem to be a favorite food. The excreta or castings thrown out of the opening where they enter the fruit, is diagnostic of codling moth infestations.

PUPA: The cocoons are found under loose scales of bark or in sheltered places on the trunks and branches of the trees. They are of a dirty whitish color containing dark brown pupæ about $\frac{3}{4}$ inch or $\frac{5}{8}$ inch in length. The adults emerge from the cocoons in the summer about eight weeks after birth.

ADULT: The adult codling moth is not often seen. This is largely due to the fact that they fly at dusk and during the day rest on the bark of the trees, the color of which they resemble.



THE ADULT OF THE CODLING MOTH
(Greatly enlarged. Third Annual Report.)

The wing expanse of the adult is about $\frac{3}{4}$ inch, and the forewings have a grayish brown scaly appearance. "When examining these wings closely one finds that they are crossed by many gray and brown scales and that near the hind angle of each front wing there is a large dark brown spot streaked with gold. The hind wings are of light grayish color 'somewhat darker toward the margin.'"



JUST RIGHT TO SPRAY FOR FIRST BROOD OF CODLING MOTH. CALYX LOBES OPEN. (Third Annual Report.)

HIBERNATING FORM: The codling moth passes the winter in most cases as the larva under scales of bark and in protected places upon or very near the trees. About 2 or 3 per cent. of them, however, pupate and pass the winter in this condition. Those living over winter in the larval stage pupate in early spring. The adult moths appear about the time the trees are dropping their bloom.

BROODS: There are two broods in Indiana and in long seasons there is possibly a third brood. The egg laying habits of the second brood differs from that of the first in that most of the eggs are laid on the fruit itself and the larvæ usually enter the sides instead of the end of the apple.

HOSTS: Apple, haw, pear and peach.

REMEDIES: Scrape off loose bark scales to destroy places of hibernation and encourage wood-peckers and nuthatches in the orchard. This practice will destroy great numbers of hibernating



TOO LATE TO SPRAY FOR FIRST BROOD OF CODLING MOTH. CALYX LOBES CLOSED. (Third Annual Report.)

larvæ and pupæ. Stored fruit should be kept behind screens to prevent the escape of adult moths.

The most effective method, however, is spraying with an arseni-

cal poison and exercising great care to fill the calyx cup (the blossom end) of the apple with the poison. The three prominent arsenical poisons are arsenate of lead, Paris Green and arsenite of zinc.

LESSER APPLE WORM.

Enarmonia prunivora—Walsh.

The lesser apple worm is becoming a rather serious pest in Indiana orchards. Its injury to the apple is produced by its feeding upon the surface of the fruit, especially where a leaf touches it.

EGG: So far as the present records of this insect go, the egg stage is unknown.

LARVA: The larva is rather variable in color but generally flesh colored. The color of its head ranges from brown to almost black and is more or less mottled, and the spindle-shaped body is about $\frac{3}{8}$ inch long. The thoracic legs and abdominal prolegs are both well developed. The tubercles are white and disc-like.

PUPA: The cocoons are generally very much like their surroundings in appearance, usually covered with bits of bark, etc. The lining is of a heavy white silk. The pupa is of a uniform brown color about $\frac{1}{4}$ inch long.

ADULT: The adult moth is black and dusky gray streaked with white and steel blue and is irregularly covered with rust red. The expanse of the wings is about $\frac{1}{2}$ inch. The life history of this insect has not been thoroughly worked out in Indiana, but it is quite evident that it is very similar to that of the codling moth.

HOST: Apple.

REMEDIES: The same remedies by which the codling moth is controlled should be effective in the control of this insect.

PLUM CURCULIO.

Conotrachelus nemuphar—Herbst.

This insect is undoubtedly one of the worst pests of the common stone and pome fruits. The larva is commonly known as the "worm" that is so often found in cherries, plums and peaches. The injury by this insect is caused by the feeding and egg punctures of the adult which attacks the young apples and pears, peaches, plums and cherries, causing the characteristic scarred and knotty appearance.



THE WORK OF THE LESSER APPLE WORM. (Original.)

EGG: The egg is small, oval and white and is deposited in a small hole made by the long proboscis of the adult. After the egg is deposited the curculio cuts a crescent-shaped segment in the flesh of the fruit to prevent the crushing of the egg as the fruit increases in size. From 100 to 300 eggs are laid by each insect, and they hatch from three to five days after being deposited.

LARVA: The larvæ are footless, cylindrical, whitish grubs about $\frac{1}{3}$ inch in length with small brown heads. When inactive they usually lie in a curved crescent-shaped position. This stage lasts from twelve to eighteen days.

PUPA: When the larva is full grown it leaves the fruit and enters the ground, where it forms a cell a few inches beneath the surface. In this it changes to a delicate white pupa about $\frac{1}{4}$ inch long. It remains in this stage from twenty to thirty days before coming to the surface as an adult curculio.



THE PLUM CURCULIO.

Greatly enlarged. (Original)

ADULT: The curculio is called a snout beetle on account of its long well-developed proboscis. Its body is short and thick, about $\frac{1}{4}$ inch long and of a brownish color, marked with gray and black. The wing covers have four black ridged tubercles which gives them a general roughened appearance. The adults come out from their hibernating places about the time the leaf buds are opening in the spring. They immediately begin to feed upon the leaves until the fruit is set. It requires about ten weeks from the time the eggs are laid before the insect reaches its full develop-

ment. The egg-laying period is somewhat drawn out and consequently the emergence of the second brood is irregular and continues until the latter part of September. Considerable injury may be noticed in this State from the feeding of the adults on the ripened fruit.

HIBERNATION: The curculio passes the winter in the adult stage—hibernating under leaves, grass and trash of all descrip-



THE INJURY CAUSED BY PLUM CURCULIO ON YOUNG APPLES.

(Third Annual Report.)

tion in and near the orchard. Woodlands located near the orchard furnish an ideal place for them to spend the winter.

Hosts: Plum, peach, cherry, apple, pear, wild plum, wild crab and hawthorns.

REMEDIES: Until comparatively recent years the practice of jarring the trees and collecting the insects in sheets spread beneath them was very widely used. The curculio has a habit of "playing possum" when disturbed and will drop into the sheets as if dead. This method, however, has not equaled in results the practice of spraying with arsenicals. As soon as the adults come out from their hibernating places, early in the spring, as the leaf buds are opening it is evident that poison should be placed upon their food at that time. Cultivating the ground is a very effective method in destroying a great number of curculio as they pupate

only a few inches below the surface of the soil. All infested fruit should be gathered up promptly as soon as it falls to the ground. This can be done with all fruits with the exception of cherries, which stick to the trees. Good results have been reported in holding this pest in check by allowing chickens to run in the orchard.

WOOLLY APHIS.

Schizoneura lanigera—Hausm.

For a description of Woolly Aphis see Aphids.

ROUND-HEADED APPLE BORER.

Saperda candida—Fab.

This is one of the apple insects that is usually underestimated in the amount of damage it does. The growth of young trees is found stunted and the foliage changes to a yellow color and drops prematurely before the real cause of the trouble is observed. This borer is detected by the castings, which are often slightly below the surface of the ground. The bark over the burrows becomes discolored and the presence of this insect often may be detected without seeing the castings.

EGG: The eggs are about $\frac{1}{3}$ inch long, rust brown in color, and broadly ovoid. The female beetle eats a hole in the bark in which to deposit the eggs. It requires from fourteen to twenty-one days after the eggs have been laid before they hatch.

LARVA: The head is small and the legs are lacking. The body tapers gradually from just behind the head back to the posterior end and the segments are decidedly constricted. The general shape, however, is cylindrical. The larval stage usually lasts three years.

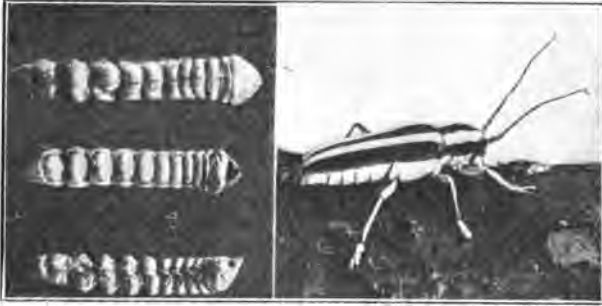
PUPA: The pupal stage lasts only about three weeks and during this stage the legs and wings of the adult are noticeable in their development.

ADULT: The adult beetle is about $\frac{3}{4}$ inch long and is a striking insect with bright silver gray legs and antennæ. The head and under surface of the body is silver white and the upper surface yellowish brown with two white stripes running the entire length.

HOSTS: Apple, quince, pear, haw, mountain ash.

REMEDIES: The trunk may be covered with a fine wire netting or building paper to prevent the adult female from depositing her

eggs in the bark. The use of a repellant wash, such as whale oil soap, soap with crude carbolic acid—1 pint to 10 gallons—have been used. Whitewash is thought by many to be good in prevent-



THE ROUND-HEADED APPLE-TREE BORER, LARVE AND ADULT.
Enlarged. (Rumsey & Brooks.)

ing the eggs from being deposited. At present, however, the most practical remedy seems to be that of digging the grubs out with a sharp knife. Whenever they cannot be reached by this method a flexible wire may be used. An unfavorable condition for this insect may be attained by keeping the orchard in a good state of cultivation and the rough shaggy bark scraped from the trees.

FLAT-HEADED BORER.

Chrysobothris femorata—Fab.

This species is very common in orchard, shade and forest trees. The damage from it, however, is slight, unless the tree has been injured or weakened from some other cause. The soft maple trees in Indianapolis have been greatly injured by this pest, due in most cases to sun scald on recently transplanted trees. Following sun scald the bark cracks loose and presents an ideal working ground for this insect.

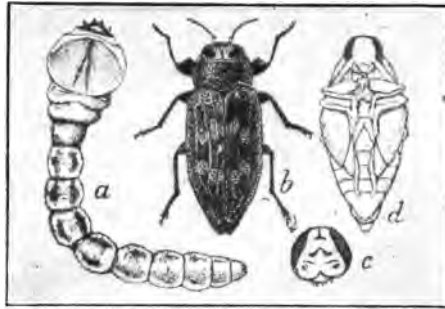
Egg: The eggs are very small—not more than $1/50$ inch long. When magnified, they show irregular furrows and are of a pale yellow color. They are deposited in crevices during the first half of the summer, sometimes singly and sometimes several in a group.

LARVA: The borer when full grown is about one inch long and is slightly curved. The second segment back of the head is greatly extended, from which the insect gets its name. The real head, however, is very small and scarcely noticeable. The larval stage lasts from eight to ten months.

PUPA: The winter is passed in the larval condition, pupation taking place the following spring, and lasts about three weeks.

ADULT: The adult male beetle is from $\frac{1}{2}$ to $\frac{3}{4}$ inch long and the female beetle slightly larger. The color is a dark bronze, almost dull metallic black. The wing covers narrow down to almost a point at the tip and are variably and indistinctly marked. The abdomen as it is seen during flight of the insect is a bright metallic blue-green.

HOSTS: Orchard, shade and forest trees.



THE FLAT-HEADED APPLE-TREE BORER.

(a) Larva. (b) Adult beetle. (c) Head of male. (d) Pupa. Twice natural size.
(After Chittenden. U. S. Dept. of Agr.)

REMEDIES: Keep the trees in a healthy condition and avoid injury to the bark of any sort. For other remedies see Round-Headed Apple Borer.

SPRING CANKER WORM.

Paleacrita vernata—Peck.

The spring canker worm is one of the so-called measuring worms on account of its looping habits of locomotion. Its distribution is wide and the damage done in Indiana during recent years is nominal, except in a rather restricted section in the northeastern part of the State.

EGG: The eggs are laid in the spring in irregular masses of about 50 in number and are usually deposited in crevices in the bark. They are oval in shape and not more than $\frac{1}{32}$ inch long. Coloring, greenish yellow. The incubation period is about one month.

LARVA: The larvæ when full grown are slender and cylindrical

with but two pairs of prolegs. They are about 1 inch in length and the color varies from gray and green to yellow. Dark olive green, however, is the most predominating color. They are marked with pale lines down the back with a white line running longitudinally along each side.

PUPA: The pupa is contained in a thin, easily torn cocoon. It is about $\frac{1}{3}$ inch in length and light brown in color.



A GROUP OF WINGLESS FEMALES OF THE SPRING CANKER WORM.

Twice natural size. (After Quaintance, U. S. Dept. of Agr.)

ADULT: The wing expanse of the male is about one inch. The female, which is from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, is wingless and resembles to some extent a spider. The color of the female ranges from gray to brown with a darker stripe down the back. The male is grayish brown in color and the wings are somewhat transparent, marked with three indistinct lines.

HIBERNATION: This insect passes the winter in the pupal stage, from which the adults emerge early in the spring.

HOSTS: Orchard fruits in general.

REMEDIES: Banding the trees with tree tanglefoot to prevent the wingless females from crawling up is a very effective method of control. If, however, the larvæ are found feeding on the foliage an application of an arsenical is advisable.

FALL CANKER WORM.

Alsophila pometaria—Harris.

The fall canker worm is so called because the moths emerge in the late fall—as late as November and December in mild weather.

Egg: The eggs are laid in clusters which are fastened at the

ends. Instead of being arranged in homogeneous masses they are in distinct rows. This characteristic designates the fall canker worm from the spring canker worm. The mass contains about 100 eggs. They are darker than those of the spring canker worm and an individual egg looks somewhat like a small inverted flower pot.

LARVA: The larvæ are very similar to the spring canker worm, but may be distinguished from them by the number of abdominal prolegs—the fall canker worm having three instead of two pairs.



THE FALL CANKER WORM.

Upper figure showing the wingless female and egg mass. Lower figure showing the winged male. (After W. E. Britton, Conn. Exp. Sta.)

PUPA: The pupa of this insect is stouter than that of the preceding, and the spine on the tip of the male is always forked. The cocoon is tough and hairy.

ADULT: The male moth has a wing expanse of about $1\frac{1}{2}$ inches. The color is darker and less transparent than that of the preceding form. The fore wings are marked with two distinct whitish bands. The female moth is of a uniform gray color with no markings, and has long antennæ free from hairs.

REMEDIES: The fall canker worm seldom occurs in numbers sufficient to demand special attention. But whenever they occur in unusually large numbers the same remedies that are recommended for the spring canker worm should be applied.

APPLE-TREE TENT CATERPILLAR.

Malacasoma americana—Fab.

The webs of the Apple-Tree Tent Caterpillar are very conspicuous in the spring on apples, wild plum and nearly all rosaceous plants.

EGG: The eggs are laid in a mass extending around the twigs in an irregular band about $\frac{1}{2}$ to 1 inch in length. This mass looks like a small swelling of the twig. There are about 200 eggs in a mass, which is covered with a pale brown glue giving it a glistening hard surface with a grayish brown color. The eggs are laid in the fall.



THE LARVÆ OF THE APPLE-TREE TENT CATERPILLAR, SHOWING
THEIR WEB.

(After Weed, N. H. Exp. Sta.)

LARVA: The caterpillars are from $1\frac{1}{2}$ to 2 inches in length of deep blue black in color. They are thinly covered with yellowish or whitish hairs and are distinguished from the larvæ of the Forest Tent Caterpillar by the white stripe down the middle of their backs. There is an oval, blue stripe with a black spot adjoining it on each segment. The caterpillar becomes full grown in from five to six weeks.

PUPA: The cocoon is a thin structure white to yellow in color, containing a large shining brown pupa about 1 inch in length. The pupal stage lasts approximately three weeks.



THE COCOONS OF THE APPLE-TREE TENT CATERPILLAR.

Natural size. (After Lowe, N. Y. Exp. Sta.)



THE ADULT OF THE APPLE-TREE TENT CATERPILLAR.

(After N. Y. Exp. Sta.)

ADULT: The adult moth is fairly heavy bodied and of a reddish brown color with two white bands obliquely across the wings. The wing expanse of the female is about $1\frac{1}{2}$ inches. The male is smaller and is distinguished by the antennæ, which are feathered.

HOSTS: Rosaceous plants.

REMEDIES: Prune out and burn the egg masses in winter or spring and cut down the old neglected apple trees and the wild cherry trees. The ordinary spring spraying with arsenicals will successfully control the caterpillars. A method that is commonly used with good results is to tie a bunch of rags or a corn cob to the end of a pole and saturate with kerosene and burn out the nest as soon as it is noticeable. On account of the numerous parasites which attack the apple-tree tent caterpillar, it only in rare instances becomes of economic importance in Indiana.

FOREST TENT CATERPILLAR.

Malacasoma disstria—Hübner.

This form is very commonly confused with the Apple-tree Tent Caterpillar on account of its close relationship.

EGG: The eggs of the forest tent caterpillar are quite like the preceding species. The general color of the egg mass is gray, showing white in spots. The number of eggs range from 150 to 225 and each individual egg is about $\frac{1}{20}$ th of an inch in length. The caterpillars gnaw off the tops of the eggs to come out. The eggs are deposited in July.

LARVA: When the larva is full grown it is about 2 inches long with blue markings modified by a horizontal whitish or cream colored stripe. There are two yellowish or whitish lines on each side.

PUPA: The cocoons are often made within the leaf with the outer surface white and with a yellow color within. The pupa is dull brown, about $\frac{3}{4}$ to 1 inch long, and from $\frac{1}{4}$ to $\frac{3}{8}$ inch wide and is covered over with a yellow powder.

ADULT: The male is somewhat smaller than the female and has a wing expanse of about $1\frac{1}{4}$ inches while the female has an expanse of about $1\frac{1}{2}$ inches. The male has a light buff color and is very similar to the female except that it is somewhat darker. The front wings are marked with an oblique dark band across them.

HOSTS: Rosaceous plants, hickory, walnut, etc.; oaks, birch and beech exempted.

REMEDIES: This form like the preceding one is very largely held in check by parasites—there being twenty-four species recorded that prey upon this insect. Large numbers are devoured by orioles, vireos and robins. Remedial measures employed are the same as for the apple-tree tent caterpillar.

FALL WEBWORM.

Hyphantria cunea—Dru.

The fall webworm differs from the apple-tree and forest tent caterpillars in the fact that it occurs mostly in August and September. The web is distinguishable from the tent caterpillar's



THE FALL WEB-WORM AND ITS WORK. (First Annual Report.)

by the fact that it covers the foliage, whereas the tent caterpillar makes a small web in the fork of the branches and never includes the foliage.

EGG: The egg masses are found on the leaves and contain from 400 to 500 eggs. The mass is of a dull green tinge, covered over with down, giving it a whitish cast. They hatch in from eight to twelve days.

LARVA: When the caterpillars are full grown, they are about 1 inch in length and are pretty well covered over with long dirty white hairs which arise from numerous black and dark brown tubercles. The tubercles and hairs vary in color in different individuals—ranging from black to yellow. The caterpillar stage lasts from four to six weeks.

PUPA: The pupæ are small—about $\frac{1}{2}$ inch long and of a brown color.

ADULT: The wing expanse of the adult moth is from 1 to $1\frac{1}{2}$ inches. It is often delicate white in color but may be more or less spotted with black. The markings are very variable.

HIBERNATION: The winter is passed in the pupal stage, from which the adult emerges as early as the middle of June in some instances, but the emergence may take place some weeks later.

HOSTS: The forest and shade trees, as well as ornamental shrubs, seem to suffer equally with the fruit trees.

REMEDIES: The web worm is to a great degree held in check by parasites, but it sometimes becomes necessary that artificial control measures be taken. The same remedial measures that are employed in the control of the tent caterpillars may be used with this insect.

PALMER-WORM.

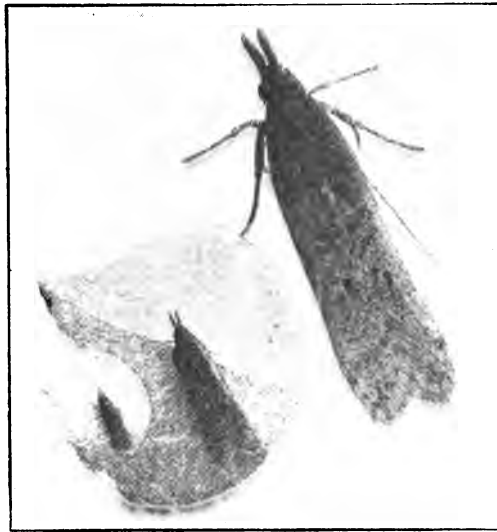
Ypsolophus pometellus—Harris.

The injury done by the palmer-worm resembles very much that done by the canker worms. The fact that this insect appears in such great numbers some years, and other years is almost absent is probably due to the great number of parasites which prey upon it. The record for this insect for the past 150 years shows that it occurs in great numbers once every fifty years. The injury to the fruit is also very much like that caused by the lesser apple worm.

EGG: This stage is unknown, but the eggs are probably laid in the spring.

LARVA: The "worms" are small and slender—about $\frac{1}{2}$ inch in length. The dorsal side is of a brownish green and the ventral is somewhat lighter. Two whitish stripes run down the sides of the body and with the two on the dorsal side give the caterpillar the appearance of being transversed by two wide dark stripes and a middle narrower one in the center of the body. The head is light brown.

PUPA: The pupa is about $\frac{1}{3}$ inch long and is found among the leaves it has eaten. The leaves are often tied together. This stage lasts about ten days.



THE ADULT PALMER-WORM MOTH. (After Slingerland Cornell Exp. Sta.)

ADULT: The adult moth is minute, gray to brownish-gray in color with a wing expanse of about $\frac{1}{2}$ inch. The front wings are marked with four black spots near the middle and the edge is dotted with black spots. The hind wings have a heavy fringe along the margin.

HIBERNATION: Contrary to the rule, this insect hibernates in the adult stage. The eggs are laid during the season following that which the adult stage is reached.

HOSTS: Oak and apple, particularly the latter.

REMEDIES: Spraying with arsenicals. The usual codling moth treatment should suffice in controlling this insect.

BUD MOTH.

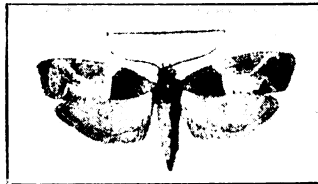
Tmetocera ocellana—Schiff.

The bud moth has been introduced into the United States from Europe on European nursery stock. During the past season it has been reported as appearing in numbers sufficient to cause considerable injury in certain localities in the northern part of the State.

EGG: The eggs are disc like, flattened, oval and transparent. They hatch from four to seven days after being laid.

LARVA: The small caterpillar is from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length and of a light reddish brown color. The head, legs, thoracic shield are very smooth and dark brown in color. The larva protects itself by forming a case of tough silken threads which is attached to leaves drawn together to form a runway. The principal damage is done in early spring when the larvæ bore into the young buds and destroys their possibility of development.

PUPA: The pupa is small—about $\frac{1}{2}$ inch in length. It is of a dark brown color and found within the silken case.



THE ADULT OF THE BUD MOTH.

(After W. E. Britton, Conn. Exp. Sta.)

ADULT: The wing expanse of the adult moth is from $\frac{1}{2}$ to $\frac{3}{4}$ inch. The fore wings are of a silver gray color with broad whitish or yellowish bands across them.

HIBERNATION: The insect passes the winter in the larval state in a gray silken nest or case which is often covered over with leaves.

HOST: Principally the apple, but may do injury to any of the deciduous fruits.

REMEDIES: On small trees this insect may be best controlled by hand picking. With larger trees, however, spraying with arsenicals is necessary and in case of bad infestations as much as 5 pounds of lead arsenate to 50 gallons of water is recommended to be applied just as the leaf buds are bursting.

LEAF CRUMPLER.

Mineola indigenella—Zeller.

The leaf crumpler, as yet, has not become a serious pest in the nurseries and orchards of Indiana, except in a few restricted localities in the southern part of the State. Its spread over the country has been brought about largely by the shipment of infested nursery stock. The winter cases of the larvæ are most commonly known and it is in this condition that it is carried from one part of the country to another. These winter cases are made of tough silken threads and are about $\frac{1}{2}$ inch in length. They are attached to small twigs by stout silk threads. In this condition they resemble the bud moth.

EGG: We have been unable to find this stage.

LARVA: The larvæ are about $\frac{1}{5}$ inch long, and are of a reddish brown color. The prothorax is black and the head is reddish. The larva is covered with pale hairs.

PUPA: The insect goes into the pupal stage which lasts about one month to six weeks. The pupa resembles very much that of the bud moth.

ADULT: The adult moth has gray fore wings marked with black and white with a triangular shaped black mark that tapers to a fine line. The hind wings are dirty white with a black border.

HOST: The leaf crumpler works principally on the apple, and has been reported on walnut.

HIBERNATION: The winter is passed in the larval stage when the caterpillar is about three-fourths grown.

REMEDIES: Destroy nests in the winter by picking them off and burning them. The ordinary summer spraying with arsenicals is effective.

GREEN APPLE WORMS.

Xylina spp.

These are peculiar in that they belong to cutworm moths (Noctuidæ) rather than moths commonly known as fruit pests. Injury from this pest has been sent in from various parts of the State but as we have not had opportunity to rear caterpillars we are not certain whether it is one or more species causing the injury. The injury is very characteristic and consists of a more or less conical hole quite wide at the surface of the apple but tapering a little as it goes into the fruit. This hole usually extends to the

core of the fruit and often beyond. The caterpillars when full grown are about an inch long and of pale apple-green color. There is a narrow whitish stripe down the middle of the back and a narrower and somewhat interrupted stripe on each side. Most injury is done about June 1 to 15. The life history depends on the species and is to be determined by further work on the insect by the office.

APPLE LEAF-HOPPER.

Empoasca mali—LeB.

This small leaping insect is able to jump a foot or more when disturbed. It is found in orchards and nursery stock in the adult form during September and October, but no great injury has been recorded in Indiana. The greatest injury, however, is produced on nursery stock which is stunted by severe attacks by this pest, which causes a curling of the foliage similar to that caused by the aphids. These insects are blamed for carrying fire blight bacteria.

EGG: The eggs are laid in the winter in blisters in the bark. They are very tiny, about 1/40 inch long, white in color and almost transparent. The summer brood deposits eggs in a great number of hosts, especial among which is clover.

NYMPH: The nymphs resemble the adults very much but are wingless and vary in size according to their age.

ADULT: The adult leaf-hopper is a pale green, slender, cylindrical insect about $\frac{1}{2}$ inch long. The head fits closely to the thorax and is distinctly rounded in front. The wings are thin and papery and are folded closely against the body. The legs are slender, the last pair being longer than the others and modified for leaping. In general, this insect resembles the grape leaf-hopper, which is figured in this report.

HIBERNATION: There seems to be doubt as to whether the adults of the apple leaf-hopper live through the winter or not. It has been shown, however, that minute eggs are laid in little blister-like swellings in the young bark of the host plants and that these hatch early in the spring.

HOSTS: Practically all kinds of nursery stock is attacked and dwarfed by the injuries of this insect.

REMEDIES: Clean cultural methods as recommended for the control of the buffalo tree-hopper should be carefully practiced. Affected trees should be sprayed either with kerosene emulsion or

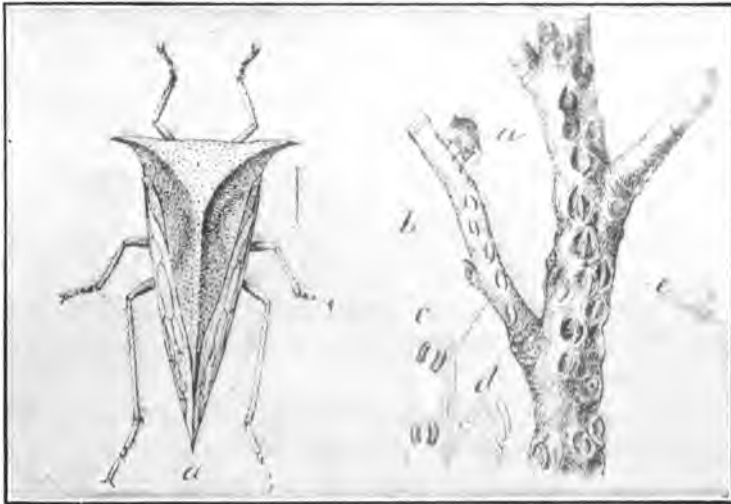
fish oil soap (one pound to ten gallons of water). The spray should be thoroughly applied and will kill all adults and nymphs with which it comes in contact.

BUFFALO TREE-HOPPER.

Ceresa bubalus—Fab.

The injury produced by this insect is a weakening of the twigs and canes made by the punctures for depositing the eggs. The injury is distinguished from that of the tree cricket or cicada by the fact that the punctures are large and circular and are not placed in regular order.

Egg: The eggs are laid in two semicircular slits. The number deposited in each slit ranges from 6 to 12 eggs. The egg laying time extends from the middle of August until frost. The bark between the slits in which the eggs are deposited is cut to prevent the crushing of the eggs during the growth of the wood. The eggs hatch in late spring.



THE BUFFALO TREE-HOPPER.

(a) Adult, enlarged. (b) Twig of apple showing recent egg-punctures. (c) Bark reversed with eggs in position. (d) Single row of eggs, enlarged. (e) Wounds of two or three years' standing on older limbs. (After Marlatt, U. S. Dept. of Agr.)

NYPH: The newly hatched tree-hopper or nymph resembles the adult considerably. It has wings and a row of spines down the middle of the back. They are known to feed on any tender vegetation.



**SCURFY SCALE SHOWING SMALL WHITE MALES AND LARGE DULL
GRAY FEMALE SCALES. (Third Annual Report.)**

ADULT: The full grown adult is about $\frac{3}{8}$ of an inch long, with color ranging from pale yellow to green. The pronotum has a sharp horn on each side, giving the insect a slight resemblance to the buffalo—a characteristic from which it gets its common name. It sometimes occurs in great numbers in rank vegetation, especially in the early fall.

REMEDIES: Keep orchard well cultivated and free from weeds so that there will be no early summer food supply for the nymphs. The twigs and limbs badly injured by egg punctures should be cut out and burned.

SCURFY SCALE.

Chionaspis furfura—Fitch.

Scurfy scale in many respects resembles the oyster-shell scale. The color of the female is dirty white and is not quite so long as the oyster-shell and more rounded. When the eggs are crushed, they are of a deep red color and resemble blood. The male scale is much smaller than the female and is pure white in color. A twig infested with male scales has the appearance of having tiny, short, white, straight marks on the surface.

The life history of this insect is practically the same as the oyster-shell scale. It appears usually on the same plants as the preceding species and methods of combating it are the same.

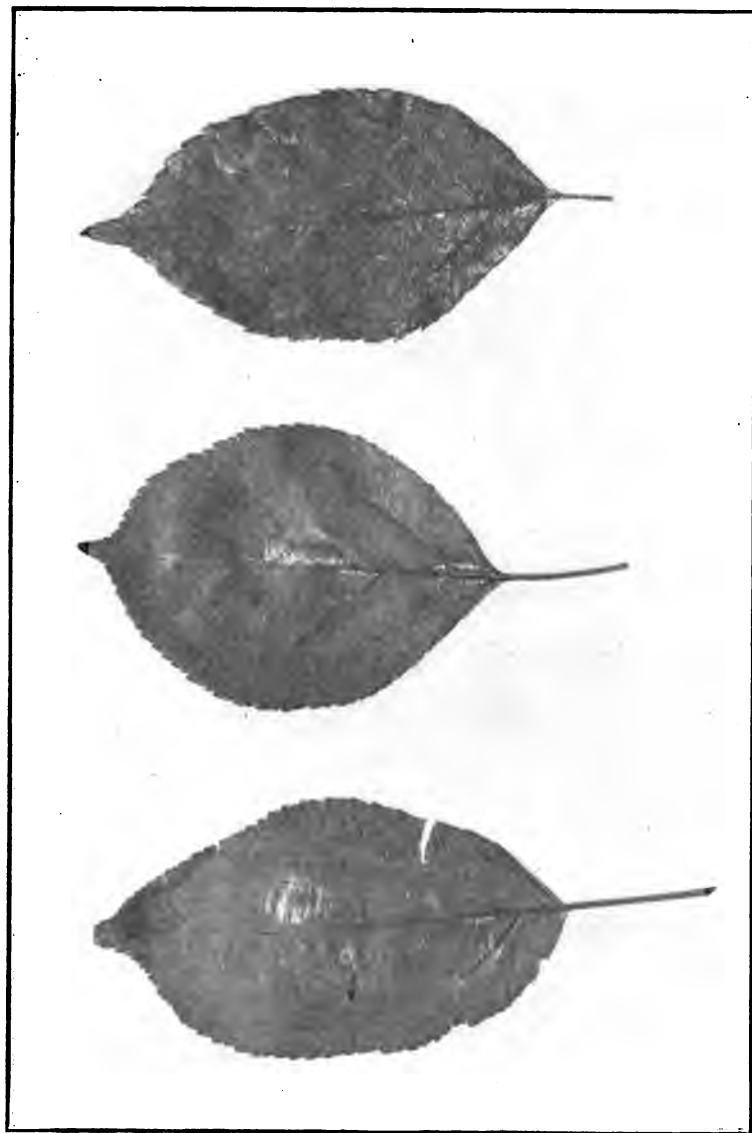
TRUMPET LEAF-MINER.

Tischeria malifoliella—Clemens.

This insect gets its common name from the trumpet-shaped mine which it makes in the leaves which show on the upper surface. It is only within recent years that this insect has become numerous enough in Indiana to receive attention.

EGG: The tiny eggs are attached firmly to the surface of the leaves. They are only $\frac{1}{50}$ inch long, elliptical in shape and of a greenish-yellow color. The incubation period is from eight to ten days.

LARVA: The young larvæ immediately after hatching burrow into the leaf tissue and continue this mining habit throughout the larval stage. When full developed, they are only $\frac{1}{5}$ inch in length. The body is pale green with a brownish head. The last segment of the body, however, is of a dusky tinge. It requires about three weeks to pass through the larval stage.



THE WORK OF THE TRUMPET LEAF-MINER OF THE APPLE. (Original.)

PUPA: The size of the pupa is somewhat variable, but usually is about $\frac{1}{8}$ inch in length. The head and thorax are brown, blending into black. The abdomen is dark green, blending into a yellowish brown.

ADULT: Clemens describes the adult moth as follows: "Head and antennæ shining, dark brown. Forewings uniform shining, dark brown, tinged purplish, slightly dusted with pale ochreous; cilia of the same general hue. Hind wings gray; cilia with a rufous tinge."

HIBERNATION: The second brood lines the mine within the leaf with silk and changes into the pupal stage and hibernates in this condition, from which it emerges about the first of May the following spring.

HOSTS: Apple, haw, wild crab, blackberry and raspberry.

REMEDIES: Plow under or rake up and burn the fallen leaves. In case of severe infestation it is advisable to spray the infested foliage with 10 to 15% kerosene emulsion. This will be effective while the insect is in the larval condition, but will not produce results after they have pupated and have become enclosed within their winter cocoon. It would, therefore, not be practical to employ this method of control later than mid-summer.

OYSTER-SHELL SCALE.

Lepidosaphes ulmi—Linn.

This scale insect is very prevalent in old neglected orchards and is very often mistaken for San Jose scale. Records show that 100 different host plants are attacked by this insect. When it gets established on young trees it frequently kills them in a few years.

Egg: The eggs are oval and white in color. They can readily be found during the winter months under the old scale covering of the female. From 40 to 100 eggs may be found under a single scale.

LARVA: The young larvæ are tiny yellow mite-like creatures which crawl about freely from about one to four days before settling down. The development from the newly hatched larva to the adult scale is very similar to that of the San Jose scale.

ADULT: The scale of the adult female is from $\frac{1}{16}$ to $\frac{1}{8}$ inch in length and its color varies from light brown to blackish. The shape is somewhat similar to the oyster shell—a characteristic from



THE OYSTER-SHELL SCALE. (Fourth Annual Report.)

which the insect gets its common name. The insect becomes full grown in about eight to ten weeks after hatching. The female then lays eggs and dies.

It is usually considered that there is but one brood in Indiana, but in long seasons there is perhaps an incomplete second generation. The adult male resembles very closely the male of the San Jose scale.

HOSTS: Deciduous fruit trees, poplar, maple, willow, lilac, etc.

HIBERNATION: This insect passes the winter in the egg stage from which the larvæ emerge in early spring.

REMEDIES: Lime-sulphur solution applied the same as for San Jose scale is partially effective, although the eggs are not all killed by it. England uses 3% caustic soda wash to kill the insects, and Prof. R. A. Cooley of Montana has found cotton seed oil and fish oil emulsion (one gallon oil, and one-half pound of soap to 10 gallons water) quite effective, either as winter spray or when eggs hatch. The process of preparing this oil emulsion is the same as that of making kerosene emulsion.

RED-HUMPED CATERPILLAR.

Schizura concinna—Smith and Abbott.

This species is very similar in habits and in injury produced to the yellow-necked caterpillar. Considerable damage has been done by this pest in neglected nurseries.

EGG: The eggs are laid on the underside of the leaves in masses similar to those of the yellow-necked caterpillar. The period of egg laying is from the last of June until the first of September.

LARVA: The larva is marked with bright red on the head and also on the prominent hump on the fourth segment. It is from this characteristic that the insect gets its common name. The body is striped with yellowish-white and dark brown or black lines, with two rows of black spines down the back. It remains in the larval condition five to six weeks.

PUPA: It is in this stage of development that the red-humped caterpillar differs decidedly from the yellow-necked caterpillar. The pupa forms a silken cocoon attached to rubbish or bits of earth, which gives it protection. The appearance of the pupa itself, however, is very similar to that of the yellow-necked caterpillar.



RED-HUMPED CATERPILLAR. (Third Annual Report.)

ADULT: The adult moth has a wing expanse of $1\frac{1}{2}$ inches. The wings are dark brown, bordered with grayish, having a dark dot near the middle, and several dark longitudinal streaks along the margin. The hind wings are uniformly brownish.

HIBERNATION: Same as following.

HOSTS: Nearly the same as following.

REMEDIES: Same as following.

YELLOW-NECKED CATERPILLAR.

Datana ministra—Dru.

The yellow-necked caterpillar, unlike the tent caterpillar and webworm, does not build a nest. It, however, feeds in colonies and often defoliates large limbs and in some instances occurs in numbers to be quite serious.

EGG: The eggs are laid in June and July in masses on the leaves, near the ends of the branches. A single mass contains from 75 to 100 white eggs.

LARVA: The larval form is the one most commonly known to the farmer and is distinguished by the orange-yellow spots just back of the head. It is about 2 inches in length, with a deep black head. The body is light colored, with long white hairs and is marked with a black stripe down the middle of the back. On each side of this black stripe are, running parallel with it, three black stripes alternating with four yellow ones. While feeding, the larvæ have a peculiar jerking from side to side. This characteristic is supposed to have developed to frighten away parasitic hymenoptera. The larval stage lasts from five to six weeks.

PUPA: The pupæ are not contained in cocoons, and pass this stage of development from 2 to 4 inches below the surface of the soil. They are about one and one-half inches long and brown in color.

ADULT: The adult moth is reddish brown in color with a lighter shade on the thorax and head. The wing expanse is about 2 inches and the front wings are marked with three or four transverse thin stripes. The margin is black. The hind wings are of a uniform pale yellow with no markings.

HIBERNATION: Winter is passed in the pupal stage in the ground.

HOSTS: Yellow-necked caterpillars feed upon a great number of trees besides apple, and seem to show a particular liking for the pear, cherry, quince, plum, hickory, oak, etc.



YELLOW-NECKED CATERPILLARS. (Third Annual Report.)

REMEDIES: Burn the masses of caterpillars with a corncob or bunch of rags saturated with kerosene or cut out and burn branches containing the colonies. Where they can be reached from the ground it is practical to crush the caterpillars by hand. Arsenicals on their food supply will effectively control these insects.

CURCULIO TWIG GIRDLER.

Ithycerus noveboracensis—Forst.

The range of this insect extends from Canada to Texas and has been reported from various sections of this State. In the event of increased numbers it will become of considerable economic importance. It has been observed by the late C. V. Riley and B. W. Douglass doing damage to trees by gnawing off the tender twigs.



THE CURCULIO TWIG-GIRDLER AT WORK. (Second Annual Report.)

ADULT: The adult beetle is usually about $\frac{3}{4}$ inch long, but is sometimes smaller. The general color is of a brownish or ashy gray with three or four rather obscure alternating black and white spots. These markings, however, are often variable. The beak is comparatively short, being about one-half longer than the head.

REMEDIES: The most practical remedy of controlling this insect when it occurs in moderate numbers, as it does in this State, is by hand picking.



THE SNOWY TREE-CRICKET. ADULT AT LEFT. EGGS AND EGG-PUNCTURES AT RIGHT. (Third Annual Report.)

SNOWY TREE-CRICKET.

Oecanthus niveus—DeG.

The monotonous cry of the tree-cricket on a summer's evening is well known to every one. This insect has been accused of eating small round holes in apples, but this is still a matter of conjecture. The principal damage caused by it is produced by making punctures in the limbs during the egg laying process.

EGG: The eggs of the snowy tree cricket are deposited in the young twigs of fruit trees and especially in raspberry canes. Shade trees are not injured very much, but they are not immune from its attacks. The punctures are arranged in longitudinal rows one to three inches long. The egg is cylindrical and oblong and slightly curved. Injury from egg punctures is often very serious.

NYMPH: The young tree-cricket resembles very much the adult, except in size and the length of its wings. It feeds on plant-lice and chews the foliage of plants slightly. This stage lasts from two to three months, making only one brood a season. The benefit accomplished by the nymphs feeding on the plant-lice is estimated to be enough to offset the injury done by the punctures made in egg laying.

ADULT: The adult is about $\frac{3}{4}$ inch in length, and of a delicate greenish-white color. The male has rounded wing covers obliquely ribbed. These ribs are the organs by which the characteristic sound is made, and therefore it is produced only by the males. The wing covers of the female are narrower than those of the male and adhere closely to the body.

HOSTS: The eggs are laid in young twigs of fruit trees, cane fruits, woody weeds, willows, soft maple and nearly all kinds of trees.

REMEDIES: Cut out and burn the eggs wherever any punctures are found. Unless the damage done by the punctures is very noticeable, there is no cause for alarm.

APPLE CURCULIO.

Anthonomus quadrigibbus—Say.

The apple curculio is often mistaken for the plum curculio, and in a sense its description may be placed along with the latter. On account of its economic importance, however, it is placed near the

bottom of the list of insects injurious to apple. It is distinguished from the plum curculio by its color, size of abdomen, length of snout, the humps on the wing covers and also the shape of the punctures.

EGG: The eggs are laid in the fruit for a period of forty-five to sixty days after the blossoms drop. The usual number laid by a single adult is 65. They hatch in about five to six days after being laid.

LARVA: The larvæ are small and white—about the size of the plum curculio, but more curved and hump-backed, being almost semicircular. Under ordinary conditions they remain in the larval state about twenty days.

PUPA: In this stage they resemble very closely the plum curculio. The most distinguished characteristic is the length of the snout, which is longer.

ADULT: The adult apple curculio is about the same size as the plum curculio. Its color is of a reddish brown, and the abdomen is more robust than that of the plum curculio. The wing covers have four very prominent humps on them—those near the head being larger than on the plum curculio. The snout is as long as the rest of the body and projects straight out instead of down as in the plum curculio. The egg cavity is not surrounded by a crescent-shaped cut as is the case in the former species.

HIBERNATION: The adult curculios enter into this state during the latter part of August.

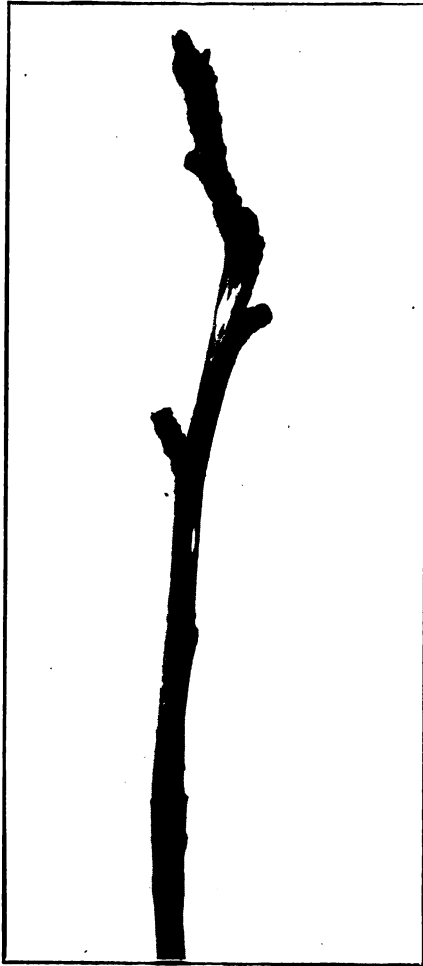
HOSTS: Apple, plum, quince, pear, haw, wild crab and wild cherry.

REMEDIES: Since the beetles show a preference to the wild crab and haws, it would be advisable to destroy such trees. They breed in great numbers in the fruit of these trees and migrate from them to nearby orchards. The remedies recommended for the control of the plum curculio applies to this insect.

APPLE BUCCULATRIX.

Bucculatrix pomifoliella—Clemens.

This insect is not as a rule destructive in Indiana, but sometimes considerable damage is done by its mining in the leaves and also by its eating on the surface. It is readily distinguished by the characteristic cocoons.



COCOONS OF THE APPLE BUCCULATRIX. (Original.)

EGG: The eggs are very minute, of a whitish color and laid on the leaves in the spring.

LARVA: The young larvæ begin their destructive work by mining the interior of the leaves, but as they increase in size they begin eating on the surface. When full grown they are from $\frac{3}{8}$ to $\frac{1}{2}$ inch long with a dark yellowish-green color, tinged with red on the anterior segments. The segments immediately behind the head are covered with short black hairs.

PUPA: It is in this form that this insect takes on a very characteristic appearance. The cocoons resemble very closely a grain of oats. They are about $\frac{1}{2}$ inch long and of a dirty white color. Close examination will reveal ribs running lengthwise. In the process of making their cocoons the caterpillars are gregarious in habits and they may be found in clusters on smaller twigs.

The pupæ are small and brown in color.

ADULT: The adult is a small moth with a wing expanse of about $\frac{1}{2}$ inch. They are so small that one would scarcely notice them flying around. The wings are heavily fringed and the forewings are of a whitish to gray color tinted more or less with yellow. Two large brown spots are noticeable near the middle.

HIBERNATION: The bucculatrix hibernate as pupæ and emerge in the spring.

REMEDIES: In case of severe infestations it is advisable to prune out and burn twigs containing great numbers of cocoons. The San Jose scale treatment during the winter with lime-sulphur solution is very effective in penetrating the papery cover of the cocoons and aids very materially in controlling this pest.

PISTOL CASE-BEARER

Coleophora malivorella—Riley.

AND

CIGAR CASE-BEARER

Coleophora fletcherella—Fernald.

These two insects are described together on account of their striking similarity in habits and development. They are very interesting little insects and in some respects resemble the bagworms. They, however, are very much smaller than the bagworm—being only about $\frac{3}{8}$ inch in length. The larvæ do damage by eating on

the surface and boring into the buds. They may be carried from one part of the country to another on nursery stock.

The following remarks on the life history applies to both species.

EGG: The eggs are very small in size, scarcely visible to the naked eye. They are highly sculptured and cylindrical in shape; of a pale sulphur-yellow color and laid loosely and singly on the under side of the leaf among the downy hairs. They are from 1/100 inch to 1/85 inch in length. The incubation period is from one to fourteen days.

LARVA: The larvæ of the Cigar and Pistol Case-bearers derive their names from the shape of the nest they carry about. The Cigar Case-bearer is about $\frac{1}{4}$ inch long. The caterpillar has a dark orange color with a black head. The case which is brown in color is made from the leaves. The caterpillar of the Pistol Case-bearer resembles the bark of the tree. The case resembles in shape an old style pistol and is made from excrement and silk. The well developed caterpillar attacks leaves, fruit and flower buds.

PUPA: The pupa case is attached so the head end extends out beyond the cocoon. The pupa is brown in both species and about $\frac{1}{3}$ inch in length. Pupal period lasts from ten to twelve days.

ADULT: The adult forms of both species are small grayish moths with a wing expanse of about $\frac{1}{2}$ inch. The wings are narrow and pointed and fringed with long hairs.

HIBERNATION: The caterpillars hibernate about the middle of September in the larval condition, and produce damage in the early spring by boring into the buds.

REMEDIES: Whenever either of these species become numerous enough to demand attention an application of arsenicals upon their feeding places will be effective.

APPLE MAGGOT.

Rhagoletis pomonella—Walsh.

This insect has not as yet been reported in Indiana, but on account of its destructive work in the East, and also the probability of its occurrence in this State at any time, a brief description will be given. The insect is also called the "railroad worm" on account of the habits of the larvæ tunnelling through the fruit. It has been found in Ohio, and through its own efforts the spread

has been slow. It is possible, however, for it to be carried over long distances in the larval stage in shipments of apples.

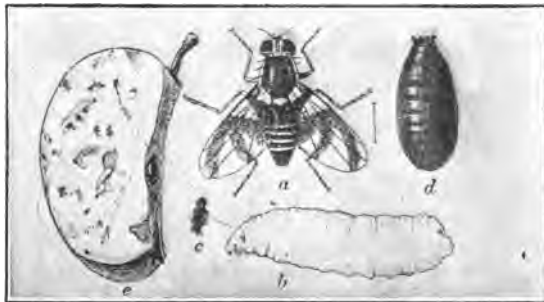
EGG: The eggs are very fine—about $\frac{3}{100}$ inch long. They are spindle-shaped and of a light yellow color. The female produces punctures somewhat like the curculio and lays the eggs beneath the skin of the fruit. The punctures, however, are not quite so noticeable and usually appear as small black specks with small depressions.

LARVA: The larvæ are about $\frac{1}{4}$ inch in length, conical in shape, yellowish-white tinged with green in color and are footless. The lower portion of the head has a number of curved black hooks. These are used in rasping into the pulp of the fruit.

PUPA: The pupæ are small, cylindrical, yellowish-brown and about $\frac{3}{16}$ inch long. This is the hibernating form.

ADULT: The adult fly has two wings and is somewhat smaller than the house fly. General color is black with dirty yellow legs and head. The eyes are of a greenish color. The abdomen of the male—which is smaller than the female—is marked with three white bands and that of the female is marked with four bands. Both males and females have four black bands across the wings.

HOSTS: Haw, apples, grapes, late cherries and plums.



THE APPLE MAGGOT.

(a) Adult fly. (b) Larva. (c) Breathing process of larva. (d) Puparium. (e) Apple showing injury. (After Quaintance, U. S. Dept. of Agr.)

REMEDIES: The most successful remedies that have been practiced in the East are: First, gathering the fallen fruit; and, second, cultivating the orchard in early summer to destroy the pupæ which have passed the winter in the ground. The effectiveness of arsenicals is questionable.

Pear Insects.

The preceding list of insects injurious to apples applies almost universally to the pear and quince. In the discussion, therefore, of the insects affecting the pear there will be no repetition of those that have already been discussed in the list of apple insects. The following list, however, contains those forms which are more strictly of economic importance on the pear.

PEAR SLUG.

Caliroa cerasi—Linn.

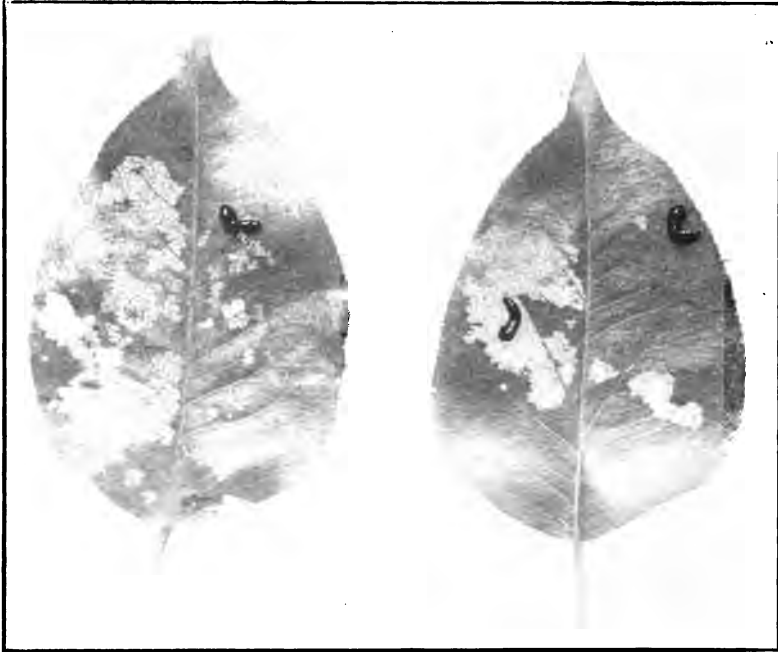
Pear slugs are very common throughout the country and during the past season have done a great deal of damage, not only to the pear but also to the cherry and plum. The brown, slimy-looking larvæ eat the surface of the leaves, causing them to turn brown, die and drop prematurely. The term slug is a misleading one, since this is a true insect and the larva of one of the saw-flies.

EGG: Quite contrary to the rule the eggs are laid within the tissue of the leaf instead of upon it. The adult saw-fly punctures the leaf from the underside and deposits its egg near the upper surface. The eggs are minute in size, being only about $\frac{1}{32}$ of an inch long and are nearly transparent. The young larvæ hatch out from seven to eighteen days after the eggs have been deposited.

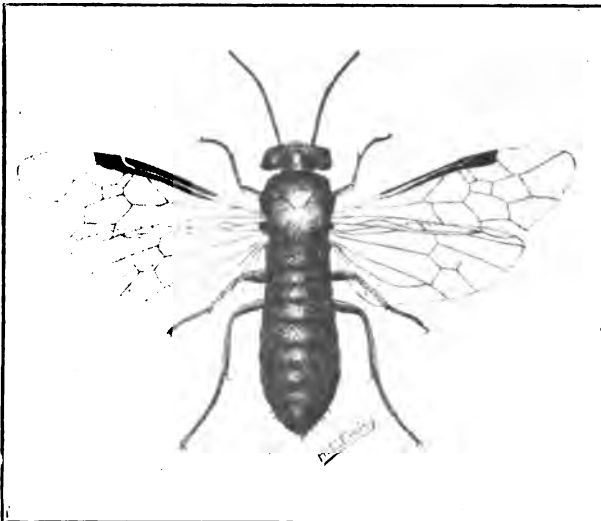
LARVA: The most commonly known stage of this pest is the full grown larva. When fully matured it is from $\frac{1}{2}$ to $\frac{5}{8}$ inch in length with a shiny appearance resembling that of the slug. The general color of the larva is dark olive green but the head is dark brown or almost black. The front segments of the body are swollen giving the larva a rather blunt appearance from the anterior end. There are 10 pairs of legs, 3 pairs of true legs on the thorax and 7 pairs of prolegs on the abdomen. The larval period lasts from two to four weeks and during the last instar of this period it turns a light yellowish-brown color with a light colored head and loses its shiny appearance.

PUPA: The fully developed "slug" enters the ground for several inches and builds a waterproof case and in this transforms to the pupa. In the pupa stage the legs are noticeable, the eyes, antennæ and wing pads of the adult may also be seen. The body in the pupa stage is of a pale yellow sulphur color and about $\frac{3}{8}$ of an inch long. The eyes in this stage are of a reddish-brown.

ADULT: The adult is a typical shiny, black saw-fly about 1/5 of an inch long, having four wings with a clouded band across the middle of each one. When the insect is at rest its wings are folded



THE PEAR SLUG LARVAE AND THEIR WORK. (Original.)



THE ADULT OF THE PEAR SLUG. (After R. L. Webster, Iowa Agr. Exp. Sta.)

across the back. The strong ovipositor at the end of the abdomen has saw-like teeth and it is used in producing the cut in which the eggs are laid. In the latitude of Indiana two generations are produced annually.

HOSTS: Pear slugs may be found on any plants belonging to the rosaceous family but their injurious work is done particularly on the pear, cherry and plum.

HIBERNATION: In the ground in the pupal stage.

REMEDIES: An application of arsenicals would always be effective but it so happens that the pear slug is often doing a great deal of damage at the time the fruit is ripe or nearly so and consequently the use of the arsenical poison is impossible. As a substitute for an arsenical poison when the fruit is ripe, hellebore or air-slacked lime should be dusted on. Whale oil soap—2½ pounds to 10 gallons of water—is also effective.

PEAR LEAF BLISTER-MITE.

Eriophyes pyri.—Pgst.

The pear leaf blister-mite has for many years been known as a rather serious pest to pear, but within comparatively recent years it seems to have turned its attention to the apple foliage and has become a serious pest on apple in some of the States. In Indiana, however, it has not become an apple pest. It is not a true insect but a mite and is related to the spiders and ticks. The well known red spider that is doing so much damage on the shade trees in the city of Indianapolis is a type of mite. The reddish colored blisters that sometimes approach black in color and are confluent in appearance, often covering the entire surface of the leaf, are characteristic of the work of this insect.

EGG: The eggs are exceedingly minute and microscopic in size. They are laid within the blisters in the spring, one single blister containing between 7 and 14 eggs. The incubation period is from seven to ten days.

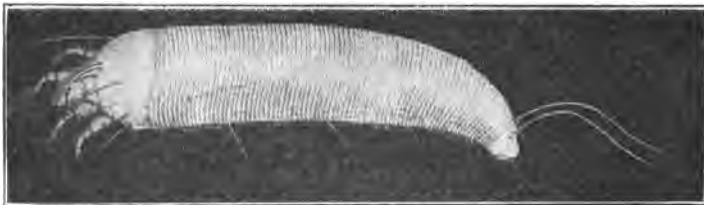
ADULT: This tiny little mite—microscopic in size—is only from 1/200 to 1/100 of an inch long and is more or less spindle shaped. It has two legs and a few bristles on the abdomen, which is composed of from 50 to 75 segments.



THE WORK OF THE PEAR LEAF BLISTER-MITE ON APPLE LEAVES AND FRUIT.

(After Parrott, Hodgkiss, Schoene, New York Exp. Sta.)

HIBERNATION: The adults pass the winter in bud scales and in the spring they migrate to the young leaves and produce the characteristic blisters. These blisters are gall-like, corky and reddish to black in color, confluent and often spreading over the entire surface



THE PEAR LEAF BLISTER-MITE.

Highly magnified. (After Parrott, N. Y. Exp. Sta.)

of the leaf. The older blisters will be noticed by perforations or tiny openings through which the mites get out from the blistered areas. When they work injury on the fruit this becomes very much gnarled or knotted in appearance.

REMEDIES: Lime-sulphur, the same as for San Jose scale, is very effective.

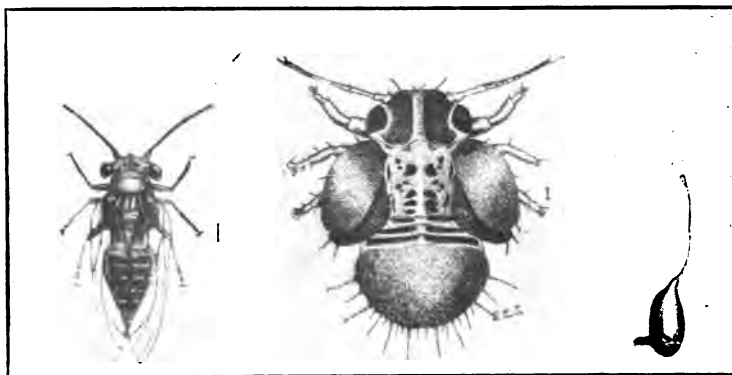
PEAR PSYLLA.

Psylla pyricola—Foerst.

The psylla is a much dreaded insect and works great destruction where it is found. It is causing serious injury in the States of Illinois and Michigan and if it is not already established here, there is no doubt about its appearing in our State before very long. Its injury is caused by its sap-sucking habit similar to that of the San Jose scale. The insects secrete honey-dew like the aphids and this causes a sooty fungus to grow on the surface of the leaves and young shoots.

EGG: The eggs are orange in color and about $\frac{1}{18}$ of an inch long. They are pyriform in shape tapering to a fine thread and the large end is attached to the bark of the tree. The eggs hatch from fourteen to twenty-one days after they are laid.

NYMPH: The newly hatched psyllæ are about $\frac{1}{16}$ of an inch long and oval in shape. The body is marked with yellowish to reddish colored marks which are sometimes black, depending upon the age. In the later stages of development wing pads are noticeable.



THE PEAR PSYLLA.

Showing adult at left, full-grown nymph at middle and egg at right. All greatly enlarged, but in different proportions. (After Slingerland, Cornell Exp. Sta.)

ADULT: In general appearance the adult resembles an aphid or plant louse but on close observation it resembles a tiny harvest fly or "locust" on account of the shape of the body and texture of the wings. The color of the summer form of the adult psylla is crimson marked with brownish black. It attains a size of about $\frac{1}{8}$ of an inch in length and has coppery colored eyes. The winter form is very dark. There are four or five broods per season.

HIBERNATION: The dark winter form hibernates beneath the bark of the host plant and emerges in early spring with the swelling of the buds.

HOST: Pear.

REMEDIES: A winter application of lime and sulphur the same strength as is recommended for San Jose scale is very effective. Those wishing to spray for this pest during the summer months may obtain considerable success by the use of whale oil soap—2½ pounds to 10 gallons of water—or by using a 10 per cent. solution of kerosene emulsion. Apply the summer sprays with a coarse nozzle.

PEAR THRIPS.

Euthrips pyri—Daniel.

The pear thrips were described in California in 1904, where they were observed doing a great deal of damage. Since that time they have been a very serious pest to all deciduous fruits, especially pear, apple, cherry and plum. Recently it has made its ap-



PEAR BUDS INJURED BY THRIPS.

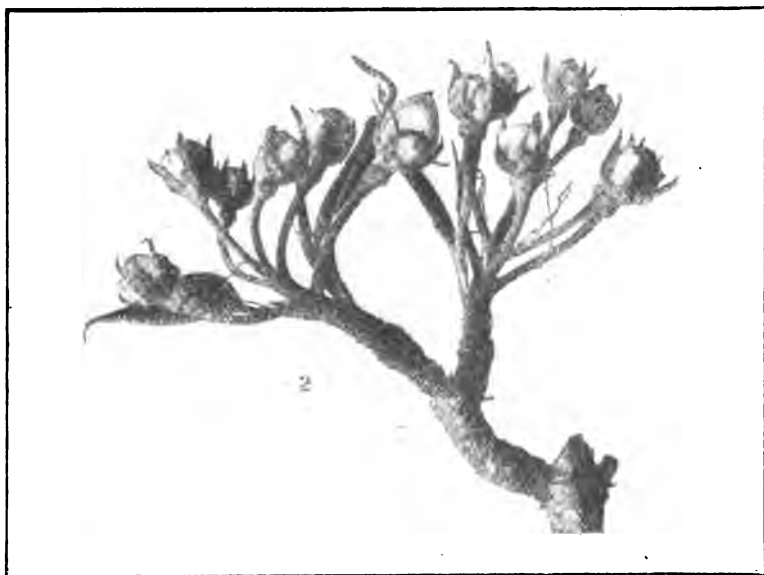
(After Parrott, N. Y. Exp. Sta.)

pearance in New York State, where it has done a great amount of damage to the fruits mentioned above by blighting the stems bearing the blossom clusters and by feeding on the fruit buds, flowers and leaf buds. Although this pest has not been reported from any section of our State, yet it seems appropriate that a short de-

scription of it should be given in order that fruit growers may be informed, since there is a possibility of its gaining a foothold in Indiana.

EGG: The tiny kidney-shaped eggs which are microscopic in size are laid in the tissues of the blossom, leaf and stem of the deciduous fruit trees. The sweet cherry seems to be quite a favorite plant on which to lay its eggs.

LARVA: The larval form is very much like that of the adult except in size and color and is without wings. They are small, soft-bodied, white insects not over 1/20th of an inch long when full grown. The mouth parts are similar to those of the adult and the larvæ therefore do a great deal of damage.



HEALTHY PEAR BUDS.
(After Parrott, N. Y. Exp. Sta.)

ADULT: This is perhaps the most destructive stage of this pest. The adult thrip is about 1/20th of an inch long with a dark brown to almost black color. The insect has four highly fringed and delicate wings. The mouth parts, as in the case of the true bugs, are primarily for sucking. The sucking apparatus is made up of a broad, conical shaped structure projecting down from the under side of the head. The points of the mouth parts are

quite sharp and of a horny nature adapted for piercing soft, vegetative tissues. The adult feeds on the tender flowers and leaf structures, causing severe damage to them.

HOSTS: Deciduous fruits are all subject to the attack of this pest. The pear, especially the Kieffer and Seckel varieties, are most susceptible. Apricots, apples, peaches, plums, sweet and sour cherries are all included in the thrip's list of food plants.

HIBERNATION: The adult thrip hibernates in the ground, from which it emerges from the middle to the latter part of April.

REMEDIES: Nicotine sprays have produced very good results in controlling this pest, but the best results have been obtained by a combination of the nicotine sprays with either the kerosene emulsion or soap solution.

Plum and Cherry Insects.

PLUM CURCULIO—(See Apple Insects).

FRUIT-TREE BARK-BEETLE.

Scolytus rugulosus—Ratz.

Fruit trees infested badly with the fruit-tree bark-beetle have the appearance of having been struck by a charge of birdshot. On plum, cherry and peach—if the tree is not nearly at the point of death—gum exudes; but on pear and apple this is not the case. If one will observe one of these small openings made by the bark-beetle he will see a small black beetle crawling in and out through the opening. This is the adult form of the insect producing the injury. It is almost a universal rule that trees weakened from some other cause are the ones that are attacked by this pest.

EGG: The eggs are rather minute in size and are laid in galleries excavated by the female between the bark and the sap wood.

LARVA: The small larvæ are distinctively curved and of a whitish color, about $\frac{3}{16}$ of an inch long. These tunnel out small sized galleries from the main ones produced by the female. The larvæ mature in about twenty-one days. There are three broods in the central western states.

PUPA: The pupæ are white to brownish in color according to age. They are small, only about $\frac{1}{8}$ of an inch long and show legs, antennæ and wing pads of the adult.



THE WORK OF THE FRUIT-TREE BARK-BEETLE.
Fourth Annual Report.

ADULT: The adult is a small beetle about $\frac{1}{4}$ of an inch in length of uniform black color. Close examination shows that the tips of the wing covers and parts of the legs are of a reddish tinge.

HOSTS: Plum, cherry, peach, pear and occasionally apple.

REMEDIES: Cut out and burn all dead and diseased wood, as it is the diseased parts of the tree through which the insect is most likely to gain entrance. Good cultivation and fertilizing to produce strong healthy trees is the best preventive measure. Gossard of Ohio reports good results from whitewashing with salt and a little cement added to the whitewash to make it stick to the tree.

PLUM GOUGER.

Coccotorus scutellaris—Lec.

The plum gouger is often mistaken for the plum curculio but it is distinguished from the latter by the absence of the bumps on the back. Its injury produces gnarled and worthless fruit like that produced by the plum curculio.

EGG: The eggs are deposited just beneath the surface of the plum while the pit is still soft. They are small, whitish to yellowish in color and hatch about one week after oviposition.

LARVA: The common name of this insect is derived from the habits of the larva eating into the pit and feeding on the meat of the seed. The larva resembles very much that of the curculio in size and form but it is of a chalky white rather than of a shiny white and does not have the reddish tinge as does the larva of the plum curculio.

PUPA: The pupa stage, unlike that of the plum curculio, is passed in the pit of the fruit.

ADULT: Before the larva goes into the pupa stage it cuts a hole through which the adult beetle escapes. The adult beetle is from $\frac{3}{16}$ to $\frac{1}{4}$ of an inch in length and has a snout about $\frac{1}{8}$ inch long. It is of a dull gray color, finely marked with black-brown; the head and thorax spotted with dark lemon yellow.

HIBERNATION: Practically the same as the plum curculio.

HOSTS: Native plum, wild and cultivated.

REMEDIES: The jarring method, as prescribed in the control of the plum curculio, has been used effectively and there is no doubt about the arsenical poisons such as are used for plum curculio also being effective.

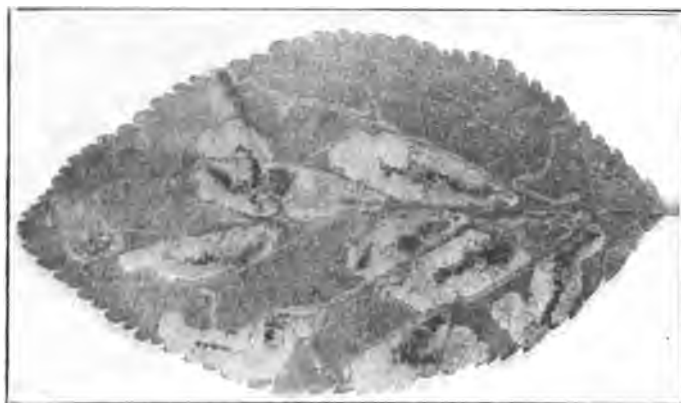
PLUM LEAF-MINER.

Nepticula stingerlandella—Kearfott.

Severe infestations of the plum leaf miner will cause defoliations of the trees and the early dropping of the fruit. It works between the upper and lower epidermis of the leaf somewhat like that of the apple miner. The writer is not familiar with its occurrence in Indiana sufficiently to be a serious pest.

EGG: The eggs, which are oval in shape and about $1/75$ of an inch in length, are laid on the under side of the leaf. On account of their minute size and also their transparency they are very difficult to find. The incubation period is about two weeks.

LARVA: The commonly recognized form of this pest is the larval condition, together with the damage done. It is a true leaf



THE WORK OF THE PLUM LEAF-MINER

(After Crosby, Cornell Exp. Sta.)

miner, working entirely between the surfaces of the leaves. When it is full grown it is of a pale green color—almost white. The head is light brown and the body is semi-transparent, showing the dark colored alimentary canal extending lengthwise through the body like a stripe. The length of a full grown larva is about $1/6$ of an inch. The shape of the mine is irregular, oval and started from the under side of the leaf. As many as a dozen mines may occur in a single leaf.

PUPA: When the larvæ reach full development they drop to the ground, where they make their way into a crack in the soil, where they make a brownish, flat cocoon. The pupa is very small,

not more than 1/12 of an inch long, the under side of which is yellowish brown; the upper side of a greenish color. An orange tuft is quite noticeable on the head through the pupa's skin.

ADULT: Kearfott in his original description of the adult form of the plum leaf miner describes it as follows: "Head with tuft is orange, thorax bronzy black, abdomen light gray, legs yellow white, fore wings bronzy black, with white stripe on outer third. Hind wings and fringe light gray."

HIBERNATION: The plum leaf-miner passes the winter in the ground in the pupa stage.

HOSTS: Plum and prune, and may attack apple.

REMEDIES: This insect is hard to control but the best results may be obtained by cultivating the ground in order to destroy the larvæ before they have pupated and also the pupæ in the cocoons.



THE FORBES SCALE ON CHERRY.

Greatly enlarged. (Fourth Annual Report.)

CHERRY SCALE.

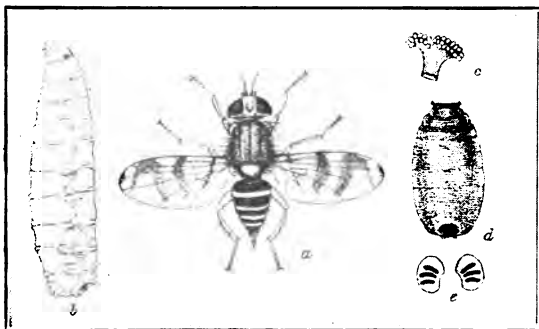
Aspidiotus forbesi—Johnson.

This scale is a native one and is quite common on sour cherries throughout the State. It is very often mistaken for San Jose scale but may be distinguished from the latter by its larger size and its more or less chestnut brown color. Its life resembles very much that of the San Jose, to which it is closely related. The remedies recommended for San Jose scale are applicable to this pest wherever it becomes serious enough to warrant treatment.

CHERRY FRUIT-FLY.

Rhagoletis cingulata—Loew.

The cherry fruit-fly is a close relative to the apple maggot, and wherever it occurs it works serious damage to the fruit. Although this office has not been notified of its appearance in any place



THE CHERRY FRUIT FLY.

(a) Adult. (b) Larva. (c) Breathing processes of larva. (d) Puparium. (e) Breathing processes of pupa. All enlarged. (After Chittenden, U. S. Dep. Agr.)

within the State, yet it is very probable that it is to some extent established here, as it is known to occur in Michigan. On account of the close resemblance of its work to that of the plum curculio the damage may easily be attributed to the latter. The habits and life of this pest are very much like those of the apple maggot, which is described in the insects affecting the apple. The larva cannot be distinguished from the apple maggot, and it therefore becomes necessary that an adult be reared before an infestation of cherry fruit-fly can be diagnosed. The adult, however, is smaller than that of the apple maggot, having a wing expanse of about $\frac{1}{4}$ inch. The color of the body, which is about $\frac{1}{6}$ of an inch long.

is almost black. The head and legs are light brown and the thorax is marked with a longitudinal yellow band. The abdomen is ringed with whitish or pale brownish bands. The wings are crossed with four dusky bands.

Grape Insects.

The insects affecting the grape were pretty thoroughly discussed in the third annual report of this department, but on account of the supply of these reports having been exhausted for more than a year, the following discussion of insects injurious to grape seems advisable.

GRAPE-BERRY MOTH.

Polychrosis viteana—Clemens.

This is perhaps the most widely distributed and also the most serious grape insect pest in the State. The little dark colored worms found on the grapes are the larvæ of this species. They bore into the green fruit, causing purplish spots to appear resembling very much those caused by black rot. Splendid opportunity is offered by the injury caused by the grape-berry moth for a secondary fungous infestation.



THE GRAPE-BERRY MOTH.

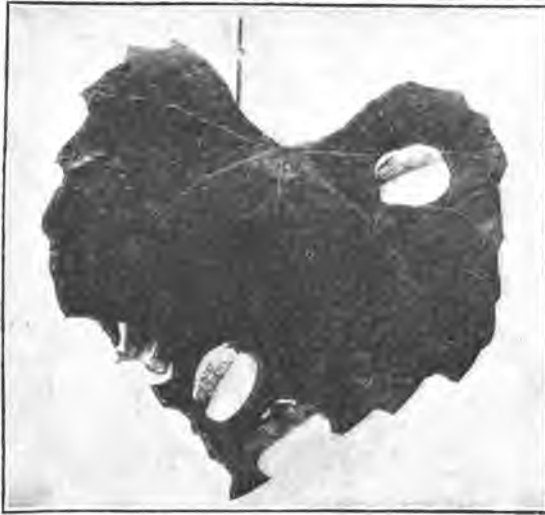
Showing the larva inside of grape. (After Slingerland, Cornell Exp. Sta.)

EGG: The eggs of the grape-berry moth are not hard to see although they are minute in size. They are flat or scale-like and appear like glistening white specks on the skin of the grape or on the stems close to the fruit.

LARVA: When the larvæ are fully developed they are about $\frac{3}{8}$ inch long, with a dark olive green to a purplish color. The head is light brown and the thorax black. The body is sparingly covered with hairs which arise from rather indistinct dark spots. The legs are well developed.

The first generation of the larvæ pull the clusters of recently set fruit together and feed on them. The second generation web several large berries together.

PUPA: A piece is partially cut out of the leaf by the larvæ; three sides are cut loose and the fourth side left intact; the cocoon is completed by folding the free sides over and fastening,



THE COCOONS OF THE GRAPE-BERRY MOTH.

(After Slingerland, Cornell Exp. Sta.)

making an inclosure within which the larvæ build their silken cocoons.

PUPA: The pupa is dark green or dirty brown and the insect remains in this condition from ten to fourteen days.

ADULT: The adult is a blackish-brown moth which has a wing expanse of about $\frac{1}{2}$ inch. It resembles the codling moth with the exception of the dark brown spots.

HIBERNATION: The winter is passed in the larval stage in cocoons on the fallen leaves. There are probably three complete broods in this latitude.

HOSTS: Both wild and cultivated grapes, blackberry, roses, iron weed, thistle, sumac, magnolia leaves, etc.

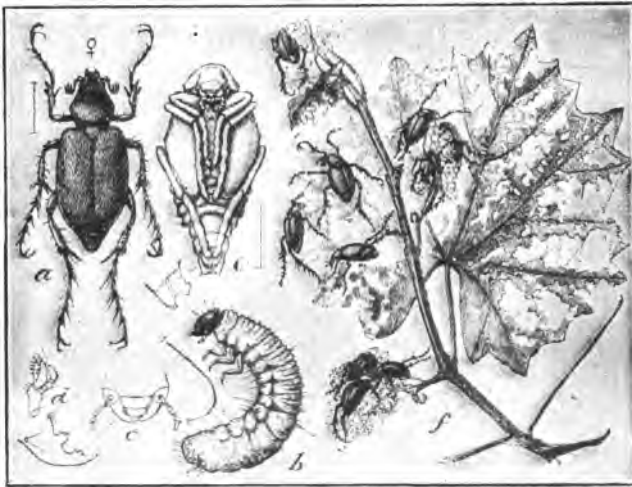
REMEDIES: Raking up and burning or plowing under the fallen leaves in the fall will help materially in controlling this insect, and spraying with arsenate of lead, 3 pounds to 50 gallons, will

successfully control the berry moth. This spraying should begin just previous to the opening of the blossoms in the spring and should be followed by a second application after the fruit has set. A third spraying about the first of July with the same amount of poison will be necessary for the complete control. In small home vineyards it is advisable to "bag" the grapes immediately after the fruit is set. This method, however, is impractical where large quantities are grown.

ROSE-CHAFER.

Macrodactylus subspinosus—Fab.

This insect derives its common name from its habits of feeding on roses and other plants belonging to the same family. It attacks grapes about blooming time and eats the blossoms and newly set fruit, often causing very serious injury.



THE ROSE-CHAFER.

(a) Adult female. (b) Larva. (c and d) Mouth parts. (e) Pupa. (f) Grape leaves infested with adults. Much enlarged. (After Marlatt, U. S. Dept. Agr.)

EGG: The eggs are laid singly in the soil about 4 to 6 inches below the surface; they are deposited about the middle of June—each female laying from 12 to 18 eggs which hatch in two or three weeks from the time they are laid.

LARVA: The larvæ resemble very much the common white grub, except that they are smaller, being only about $\frac{3}{4}$ inch long. They spend the remainder of the summer after hatching in the

ground feeding on the roots of grass. At the approach of winter they bore down beneath the frost line, and do not pupate until towards spring.

PUPA: The whitish pupæ are from $\frac{1}{2}$ to $\frac{5}{8}$ inch in length and are found in spring near the surface of the soil in a more or less oval or elliptical cell built by the larvæ. They remain in this stage from two to four weeks, depending upon the temperature.

ADULT: The fully developed rose-chaffer is the form most commonly met with, except possibly the larval form. The adult beetle is of a light chestnut brown color and is from $\frac{1}{3}$ to $\frac{1}{2}$ inch in length. The legs, as you will note from the cut, are long, awkward, clumsy and spiny.

HIBERNATION: As indicated above, the winter is passed in the larval condition below the frost line in the soil.

HOSTS: The rose-chaffer is a very general feeder, and besides its injury to the grape, it feeds on the flowers of the apple, plum, cherry, peach, vegetables, grasses and grain.

REMEDIES: The fruit may be protected from injury of these insects by bagging the fruit immediately after it has set. By hand picking one may materially reduce their number, but this method is generally considered too tedious. Jarring them into a canvas-covered frame which slopes to a container will get great numbers of them when they are numerous and a very strong solution of arsenate of lead may be necessary to effectively control this insect. From 5 to 10 pounds to 50 gallons of water will be necessary for good results.

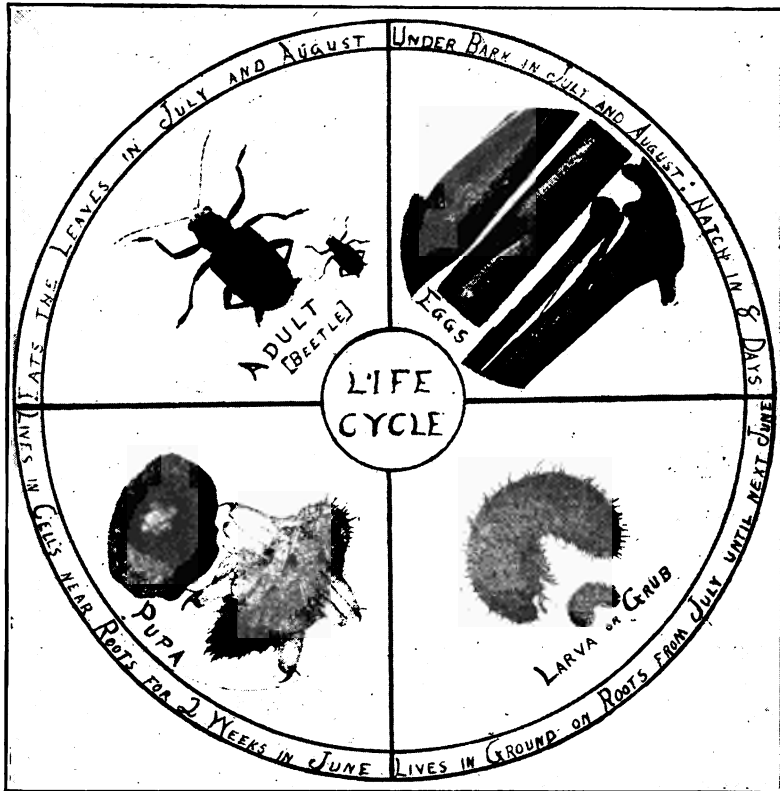
GRAPE ROOT-WORM.

Ptidia viticida—Walsh.

The injury produced by the adults of this insect on the leaves is quite characteristic, as they chew the surface of the leaves in chain-like patches. On account of the habit of the larvæ eating on both the larger and smaller roots, it is called the grape root-worm. It becomes a very serious pest in light sandy soil and has become quite a problem in the grape growing districts throughout the range of its distribution, which includes practically every grape-growing section of the country.

Egg: The eggs are deposited beneath the loose bark on the old canes in masses of two to three dozen. The single egg, which is about $\frac{1}{25}$ inch long, is oblong and elliptical with slightly taper-

ing ends. The color is whitish or yellowish, depending upon the age. They are deposited the latter part of June and hatch from nine to twelve days later.



THE LIFE CYCLE OF THE GRAPE ROOT-WORM.

Enlarged and natural size. (After Slingerland, Cornell Exp. Sta.)

LARVA: In this stage of the insect it is rather heavily covered with spines and is from $\frac{1}{16}$ to $\frac{1}{2}$ inch long, depending upon its age, and resembling a small grub worm. It is of a whitish color with brown head and are entirely root feeders. The larval stage lasts eight months.

PUPA: The insect remains in this condition from fourteen to eighteen days. The pupa, which is from $\frac{1}{4}$ to $\frac{1}{3}$ inch in length, is whitish in color tinged with pink and, as in the case of the larva, has numerous spines.

ADULT: The adult beetle is brown in color and well covered with grayish hairs. The body is robust with long legs and is about

$\frac{1}{4}$ inch in length. It is in this stage only that the injury is produced on the leaves.

HIBERNATION: In the larval state below the frost line in the soil.

REMEDIES: The adults may be killed by thoroughly spraying with arsenate of lead, 4 pounds to 50 gallons, about the time they appear.

Since the larvæ come close to the surface to pupate and as the pupæ usually die if the cell in which they pupate is broken, thorough cultivation sometimes will be found effective. Also by throwing well tilled soil up close to the vines will prevent many of the young larvæ from working their way through to the roots.

GRAPEVINE FLEA-BEETLE.

Haltica chalybea—III.

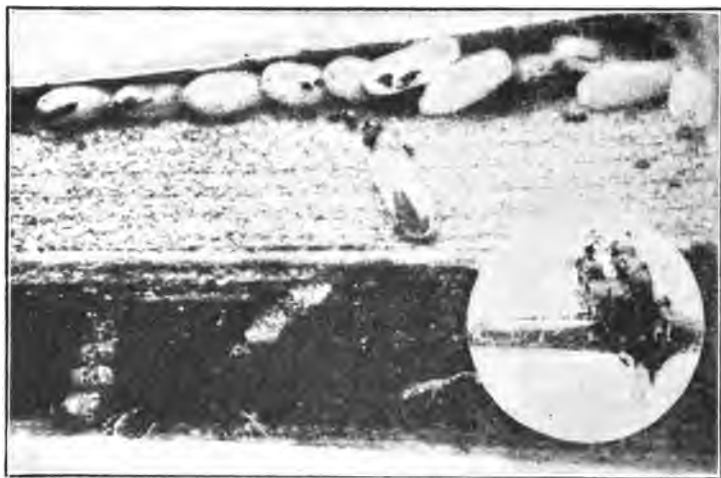
This insect is called a flea-beetle because the hind legs have thick and well developed thighs, which enables the adult to jump for a considerable distance when it is disturbed. This species is



LARVA OF GRAPEVINE FLEA-BEETLE ON LEAF. (Original)

quite common in Indiana and it does considerable damage both in the adult stage by eating into the buds in the spring and in the larval stage by riddling the leaves as the season advances.

Egg: The eggs are laid in a regular group around the buds before the leaves expand. They are about $\frac{3}{100}$ inch in length, oval in shape, and of a buff yellow color. The incubation period is from two and one-half to three weeks.



THE EGGS OF THE GRAPEVINE FLEA-BEETLE.

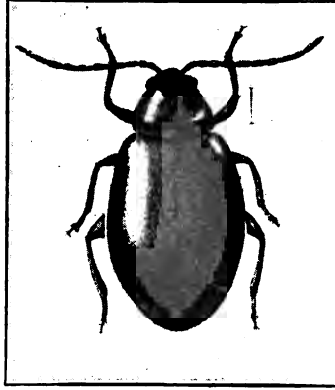
Greatly enlarged. (After Slingerland, Cornell Exp. Sta.)

LARVA: The full grown larva is of a dark brown color dotted with rows of blackish tubercles, each of which bears a single hair. Its length is about $\frac{1}{3}$ inch. The head, prothorax, legs and the last segment of the body are black. The larval period lasts from three to four weeks, during which time the grubs feed upon the upper surface of the leaves.

PUPA: The larvæ form a small cavity very close to the surface of the ground by squirming about and in this the pupal stage is passed.

The pupa is reddish-yellow with red brown eyes. On the dorsal side of each segment may be seen a row of short dark colored hairs. The time required to pass through this stage is only one week.

ADULT: The adult beetle, which is only about $\frac{1}{5}$ inch in length, is stalky and of a steel blue to greenish color. The thighs of all the legs are thickened to some extent, but those of the hind legs are best developed.



THE ADULT OF THE GRAPEVINE FLEA-BEETLE.
(After Quaintance, U. S. Dept. of Agr.)

HIBERNATION: The adult beetle hibernates in any sort of a protecting crevice close to or in the vineyard.

HOSTS: Both wild and cultivated grapes, but is sometimes found feeding upon plum, apple, pear, quince, blue beech, and elm.

REMEDIES: Spray with arsenate of lead at the strength of about 8 pounds to 50 gallons, as soon as the slightest injury is shown on the buds. In small vineyards, hand collecting every morning will be effective.

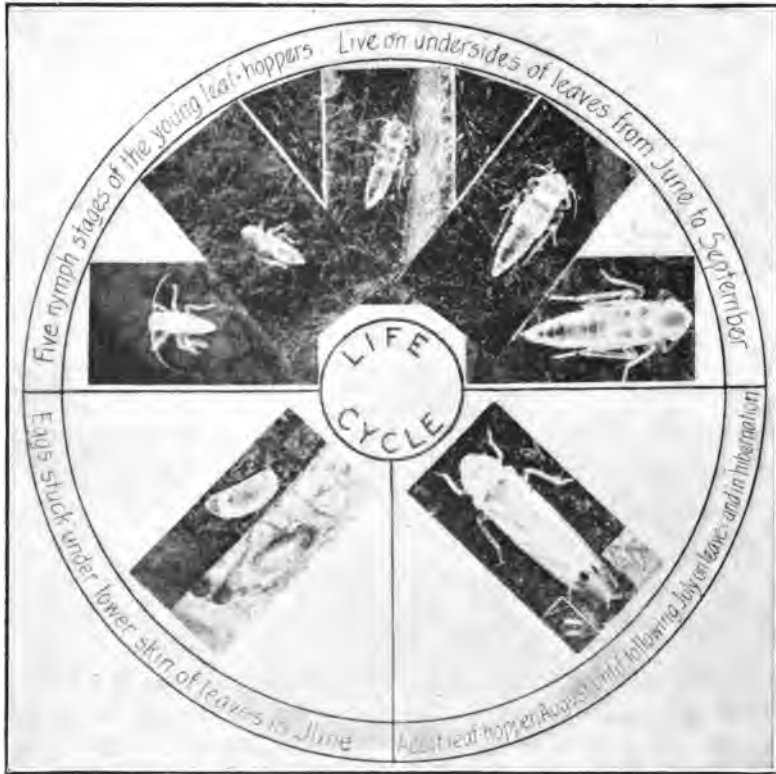
GRAPE LEAF-HOPPER.

Typhlocyba comes—Say.

This insect is very common throughout the State. As a rule its injuries have not been serious enough to attract much attention. As the leaf-hoppers belong to a division of true bugs, they have sucking mouth parts. Each feeding puncture makes a tiny white spot, due to the injury to the cells of the leaf and where the injury is serious, the leaf has a variegated appearance. Turning yellow and premature dropping of the leaves is the result of continued and increasing injury.

Egg: The eggs are sometimes laid singly, but more usually in groups of from 6 to 9, just beneath the surface of the leaf. They are less than $\frac{1}{32}$ inch in length and are transparent, except just previous to hatching, when the eyes of the embryonic nymphs may be seen as dark specks. The eggs are deposited in the latter part of May and the young nymphs hatch from ten to fourteen days later.

NYMPH AND ADULT: The nymphs range in length from $\frac{1}{32}$ to $\frac{1}{8}$ inch, depending upon the instar. There are five molts or instars, before the adult stage is reached and with each molt the wing pads become more conspicuous. While in this stage the insects are of a light yellow-green color. The adult, which is about $\frac{1}{8}$ inch in length, is bright yellow and has red markings on the wings. The hibernating individuals, however, have more of a reddish cast, owing to a change from yellow to reddish-orange.



THE LIFE CYCLE OF THE GRAPE LEAF-HOPPER.

(After Slingerland, Cornell Exp. Sta.)

HIBERNATION: The winter is passed in the adult stage beneath the leaves and rubbish in or about the vineyard.

REMEDIES: Results may be obtained by cleaning up fallen leaves and refuse in the vicinity of the vineyard, thereby reducing the number of hibernating adults. Large numbers of adults may be caught on a framework covered over with a canvas which con-

tains a coating of tanglefoot or some other sticky substance. One person may carry this alongside the vines and another person shake them, causing the leaf-hoppers to jump upon the sticky canvas. The young may be combated very successfully by spraying with whale oil soap solution, 5 pounds to 50 gallons, or by spraying with a rather strong nicotine solution. This work must be done thoroughly and a nozzle adapted for throwing the spray material on the under side of the leaves is essential.

GRAPE SCALE.

Aspidiotus uvae—Comst.

This scale is found very commonly throughout the State, especially in neglected vineyards. It is usually found on the trunks or arms of the vine beneath the loose bark. It has often been mistaken for the San Jose scale, from which it is distinguished by the color of the scale coverings and also by its size. The coverings are dirty gray ranging to yellowish brown. They are quite flat and circular with bright yellow apices while at the center they are slightly larger than San Jose scale, but are very similar to the latter in development. From 35 to 50 young are born alive during May and June. The stages of development are practically the same as those of the San Jose scale, except that there is but one brood a year and the hibernating females are almost full grown.

REMEDIES: Same as for San Jose scale.

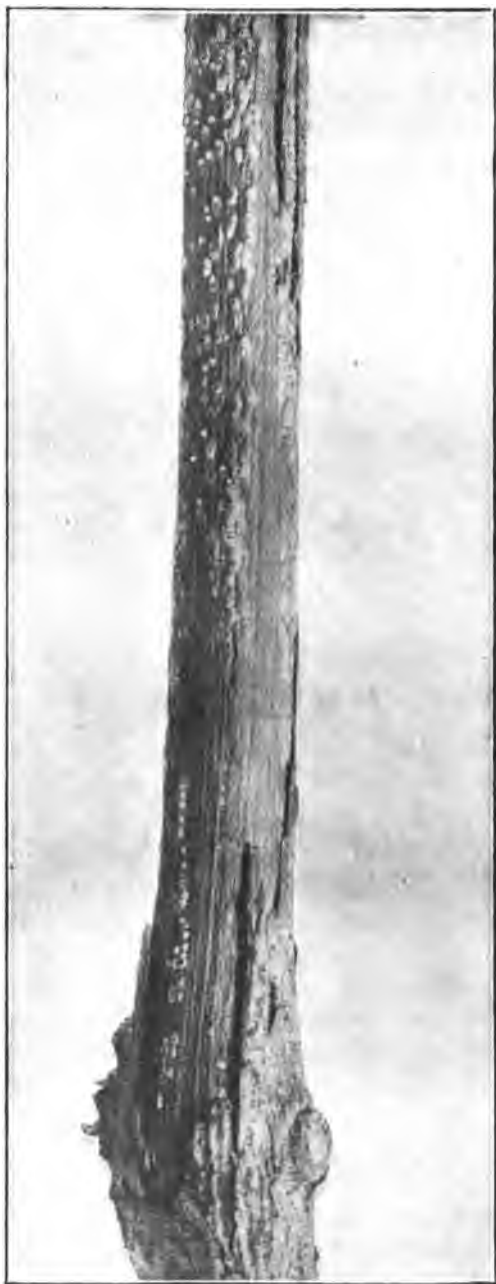
GRAPE LEAF-FOLDER.

Desmia funeralis—Hübner.

This pest has been rather serious in some localities in the State and it is not uncommon to find young vines on which every leaf is affected. The injury, which consists of eating the tissues and rolling the leaves to form a protecting case for the larva when it is feeding, is very characteristic.

EGG: The eggs are small and are placed in irregular groups on the vine.

LARVA: The larva, which attains a length of about 1 inch, is marked with several brown spots on the first two thoracic segments. The head and first segment behind the head are brown, but the general color is greenish white. When disturbed it be-

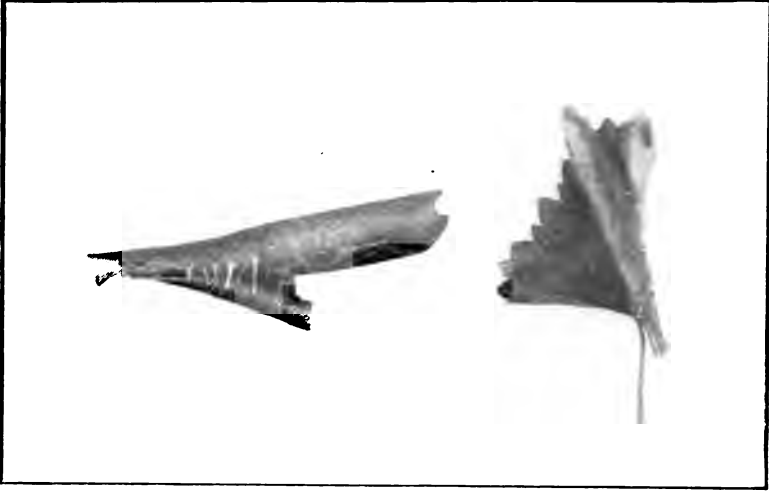


THE GRAPE SCALE.
Slightly magnified. (Third Annual Report.)

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comes exceedingly active. The larval period lasts from three to four weeks.

PUPA: The leaves that have been curled up by the larva furnish a case in which the yellowish brown pupa may be found.



THE WORK OF THE GRAPE LEAF-FOLDER. (Third Annual Report.)

ADULT: The adult moth is very pretty, with a wing expanse of about 1 inch. Both pairs of wings are black, but the front pair bears two white spots. The hind pair may have one or two spots, depending upon the sex of the moth. The body in both sexes is marked with two white bands.

HIBERNATION: The winter is passed in the pupal stage within the folded leaves. In Indiana there are two broods per year.

REMEDIES: Raking up and burning the fallen leaves in the fall or spraying with arsenicals to kill the young larvæ before the leaves are folded will effectively control this pest.

GRAPE ROOT-BORER.

Memythrus polistiformis—Harris.

This insect has been reported as doing considerable damage in Kentucky, and an account of it was also published in the third annual report of this office. We have not as yet heard of its occurrence in Indiana. There is little question, however, about its soon becoming established in the southern end of the State and as the

supply of third reports containing an account of it is out we will include here an account given by Prof. F. E. Brooks, in Bulletin 110, of the West Virginia Experiment Station:

"The mature insect is a handsome moth, the sexes of which differ considerably in size. The males vary from $\frac{5}{8}$ of an inch to $\frac{3}{4}$ of an inch in length, and from 1 inch to $1\frac{3}{8}$ of an inch in expanse. The females are larger, measuring about $\frac{7}{8}$ of an inch in length and $1\frac{1}{2}$ inches in expanse.

"The general color of both sexes is a dark, lustrous brown. The fore wings are brown and the hind wings transparent, bordered and ribbed with brown. The abdomen is circled at the posterior margins of the second and fourth segments with bands composed of orange and yellow scales intermingled, the lemon-colored scales predominating in the front band and the orange in the other. There are also spots of similar colored scales on the thorax at the base of the wings. As the moths grow old and worn with flight these markings are likely to disappear to some extent. The legs are reddish-brown and the antennae of the males brown, marked with metallic colors, and those of the female metallic purple and bronze. The antennae of the males are delicately pectinate or fringed. The female has a little orange-colored tuft on each side of the tail and the male has two tufts on each side, the middle pair being longer than the other.

"Egg: The egg is oval in outline, slightly flattened at the sides with one face evenly convex and the other marked by a deep longitudinal furrow or groove.

"LARVA: It is in this stage alone that the insect is capable of doing any injury. When first hatched the larvæ are very small, being only about $\frac{1}{25}$ of an inch in length. They are whitish in color with brown heads, and are sparsely covered with stiff hairs. When full grown some specimens attain a length of $1\frac{3}{4}$ inches. As soon as the young borer is out of the egg which, as stated, is on the ground at the time of hatching, it begins to work its way downward through the soil, evidently trusting good fortune to guide it to a grape root. The borer, after finding the root, first eats its way through the outer bark and then begins to excavate an irregular burrow, which at first is confined to the softer portions of the bark. At the beginning this burrow may encircle the root several times, but later, as the borer increases in size, it is made to run with the grain of the wood and may be extended either towards or from the base of the root.

"PUPA: When the larva is full grown and ready to pupate it leaves the root and ascends to near the surface of the ground. Here it constructs a rough, elongate cocoon, from $\frac{1}{4}$ to $1\frac{1}{4}$ of an inch in length, which is composed outwardly of grains of earth and excrement and lined with tough silk. Within this cocoon it transforms to a pupa of dark brown color with yellow bands encircling the abdomen. The cocoon stands perpendicularly in the ground, with the upper or head end beneath the surface. When about to emerge the moth works half the length of its pupa case out of the cocoon and then escapes from the case through a slit in the back. The discarded case is left with one end adhering in the cocoon and the other projecting above the ground."

GRAPE CANE-BORER.

Amphicerus bicaudatus—Say.

The writer does not know of the occurrence of this insect in the State and Blatchley, in his Coleoptera of Indiana, does not report it as being found in Indiana. Casey, however, says that it is found here; but in any event, it is one of the common pests of the grape. In some restricted localities, moreover, it may become very serious. A description of the adult and its work is herewith given.

ADULT: The adult beetle is brown in color and about $\frac{1}{2}$ inch long and more or less cylindrical in shape. The male is distinguished by rather long protuberances near the end of the wing covers. The wing covers are marked with coarse irregular punctures.

INJURY: As the common name indicates, the injury caused by this insect is by boring into the canes, usually at the axil of the shoot. It is probable that the adult digs these burrows for food, but their work seems to be prompted more or less by a malicious inclination.

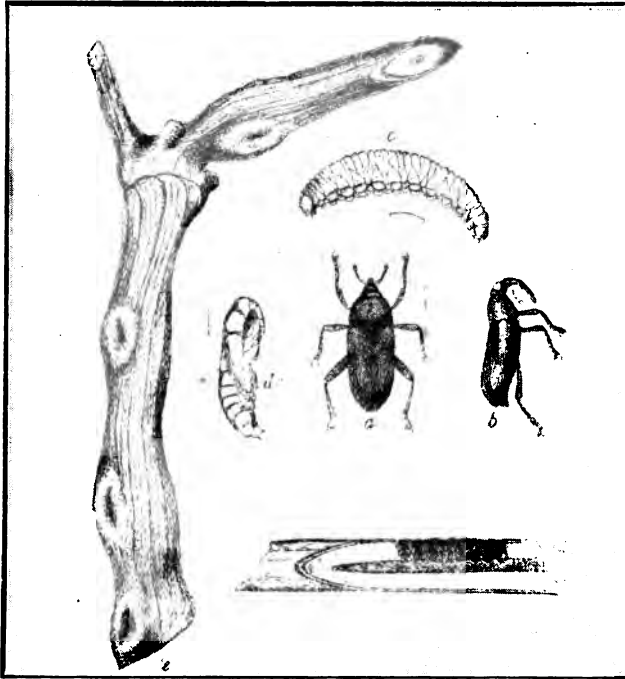
GRAPECANE GALL-MAKER.

Ampelogypter sesostris—Lec.

Although this form has been reported as injurious in our neighboring State, Ohio, by Professor F. M. Webster, we have not as yet had it brought to our attention in this State. There, however, is no doubt about its existence here and there is a probability of its becoming serious. The injury results from the egg-laying puncture.

tures in the canes which cause galls to form about 1 inch long and almost twice the diameter of the cane. The galls are deeply scarred on one side.

EGG: The female burrows out a pit in the cane with her snout in which she deposits a very small, whitish or yellowish colored egg. The location of the egg-laying injury is at the joints of the canes out beyond the outermost fruits.



THE GRAPEVINE GALL-MAKER.

(a) Adult, top view. (b) Same, side view. (c) Larva, side view. (d) Pupa. (e) Section of vine showing gall. (After F. M. Webster, Ohio Exp. Sta.). (f) Section of cane showing wound made in depositing eggs. (After Brooks, W. Va. Exp. Sta.)

LARVA: The larvæ are yellowish colored footless grubs and a little less than $\frac{1}{2}$ inch long and are slightly curved. The larval period lasts from eight to ten weeks.

PUPA: The pupa resembles very much that of the same stage in the plum curculio with the exception of not having a spine. This stage is passed within the burrow in the cane.

ADULT: The fully developed beetle is $\frac{1}{8}$ inch long and of a reddish-brown color. The back is slightly curved and is finely

penciled with longitudinal grooves. The grapecane gall-maker is one of the snout beetles and may be distinguished from the curculio by the absence of the tubercles which are so prominent on the latter.

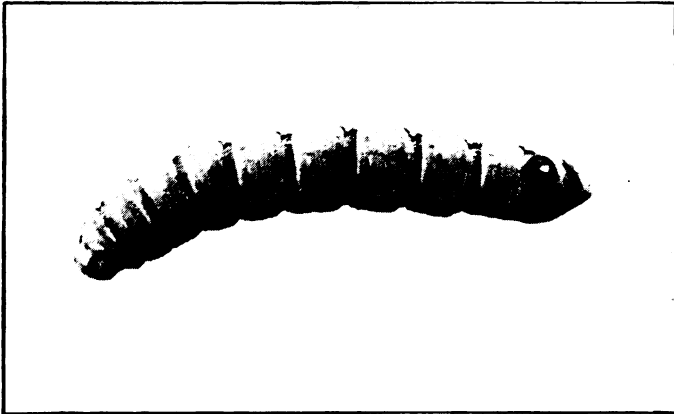
HIBERNATION: The winter is passed in the adult stage in locations similar to those of the plum curculio.

REMEDIES: Cut out and burn the galls that can be found during the latter part of July. The application of arsenicals for the other common grape pests will undoubtedly prevent this insect from doing any damage.

THE ACHEMON SPHINX.

Pholus achemon—Dru.

This is the most common species of the larger caterpillars and moths found working on the grape in Indiana. It has frequently been sent to the office for identification although in no case has it been found in numbers sufficient to be regarded as a serious pest.



THE LARVA OF THE ACHEMON SPHINX. (Third Annual Report.)

EGG: The eggs are usually laid singly on the foliage and are of a more or less round or ovoid shape, and are approximately $1/16$ inch long.

LARVA: The young larvæ are light green and as they grow later turn to a reddish-brown color. The reddish-brown horn which is so conspicuous in the early part of the larval periods disappears

with the later molts and in place of the horn a shiny, almost black, "eye-speck" appears. When full grown the caterpillars are about $\frac{3}{4}$ inch long with six greenish or creamy white spots on each side of the body from the second to the seventh segment.

PUPA: The pupæ are large and of a dark brown color. They are distinguished by having a sharp spine on the last abdominal segment. Their place of pupation is several inches below the surface of the soil.

ADULT: The adult moth is of a general grayish color with a more or less brownish cast; mottled with light brown, and marked with darker brown spots. The hind or under wings are pink and the body has a decided reddish tinge. Each pair of wings is marked with a large triangular brown spot at their base.

REMEDIES: Hand picking is practical in small vineyards, but where larger areas are to be treated, an application of arsenicals at the time the young larvæ appear is recommended.

Insects Injuring Strawberries.

STRAWBERRY ROOT LOUSE.

Aphis forbesi—Weed.

(See APHIDS.)

STRAWBERRY LEAF-ROLLER.

Ancylis comptana—Fröhl.

This pest is a native of Europe, but like the Brown-Tail Moth is not very injurious there. In this country it frequently becomes a serious problem to strawberry growers and local outbreaks have been very common in the northern part of the State in recent years. Like the grape leaf-folder, the larva of this insect has the habit of folding or rolling up the leaves. This affords protection for the larva while feeding on the leaf tissues and in consequence of the injury the leaves turn brown and die.

EGG: The eggs are quite minute and are of such a light green color it is difficult to see them. They are ovoid in shape and flattened on the side where they are attached to the leaf. They are deposited in the early spring and hatch about one week later.

LARVA: It is in this stage that the insect is most commonly known to the strawberry grower. When full grown it is about $\frac{1}{2}$ inch long with a bright brown colored head. The first segment

behind the head is also brown. The general color, however, is deep green. When disturbed these insects become very active, as do the grape leaf-rollers. The newly hatched larvæ have a very interesting instinctive habit of eating into the mid-rib of the leaf, apparently to weaken it. This makes the folding of the leaf comparatively easy. The larval stage lasts about one month.



THE WORK OF THE STRAWBERRY LEAF-ROLLER. (Second Annual Report.)

PUPA: The pupal period is spent within the folded leaf. It is of a light brown color and about $\frac{1}{4}$ inch long.

ADULT: The late J. B. Smith of New Jersey Experiment Station has described the adult as follows: "The adult moth is small, measuring with expanded wings about $\frac{2}{5}$ of an inch. In general color it is somewhat reddish-brown, the fore wings streaked and spotted with black and white as shown in the illustration. When the wings are folded the dark area at the base forms a somewhat

conspicuous deeper brown patch in the middle of the back. The hind wings are of a soft, dark smoky-gray, and both wings have long fringes. The insects fly readily during the middle of the day, and run rapidly on the leaves, diving to the under side or into a fold so quickly that it requires close watching to follow their movements. From the fact that newly set fields are often infested, it is probable that they fly for some distance to seek their food plant."

The second brood is found on blackberry and raspberry stock as well as strawberries.

HIBERNATION: The pupæ of the second brood pass the winter in the folded leaves.

REMEDIES: If treatment is neglected until after the leaves are folded, nothing can be done in holding this pest in check. Since the occurrence of the young larvæ depends largely upon the season it is important that the grower keep close watch for the first appearance of the young and apply arsenate of lead, 3 pounds to 50 gallons, as soon as he notices them. The number of adults can be greatly reduced by mowing the infested patches after the fruit is taken off. This, combined with the spraying with arsenicals, will readily control this insect.

STRAWBERRY SAW-FLY.

Monostegia ignota—Norton.

The larva of this insect resembles that of the currant saw-fly and is sometimes a rather serious pest; but being a leaf feeder it is readily controlled.

EGG: The eggs are pure white in color, tapering at each end and are about $1/20$ to $1/25$ inch long. They are deposited singly on the under side of the leaf just beneath the epidermis.

LARVA: The full developed larva is between $\frac{1}{2}$ and $\frac{3}{5}$ inch long and of a beautiful deep green color. The head is decidedly brown and the body, which is much wrinkled, is marked with one dorsal and two lateral obscure blackish stripes. The larval period lasts from fourteen to sixteen days.

PUPA: The larva works down into the ground about 1 inch below the surface and there builds a thin silk lined earthen cell, in which it pupates. The pupa is about $\frac{1}{4}$ inch long.

ADULT: The adult is a typical saw-fly of black color with four well veined wings. The length is about $\frac{1}{4}$ inch and the abdomen is marked on either side with cream colored spots.

HIBERNATION: The larva enters the ground in early June and remains there until the following spring when pupation takes place.

REMEDIES: The larvæ are readily killed by the use of an arsenical, for the application of which see Strawberry Leaf-Roller.

STRAWBERRY CROWN-BORER.

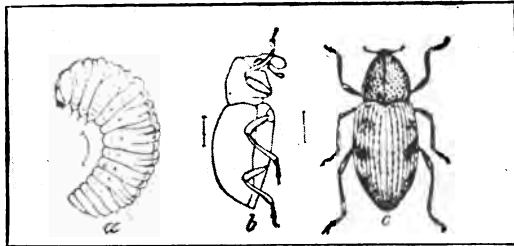
Tyloderma fragariæ—Riley.

This insect is best known by its larva, which is a small white grub working in the crown of the plant, girdling it so completely that the center may be readily pulled out. Affected plants are usually much stunted in growth or entirely dead. This pest has done considerable damage in the strawberry fields in the vicinity of Borden, Indiana.

EGG: The eggs of this pest have not as yet been observed by entomologists. Careful search in the infested fields have not revealed them.

LARVA: This is a typical curculio larva, legless and not more than $\frac{1}{4}$ inch long, rather wrinkled and to some extent curved. The general color is white with the head light brown.

PUPA: This stage resembles very closely that of the plum curculio and is found in the feeding burrows of the larvæ.



STRAWBERRY CROWN-BORER.

(a) Larva. (b and c) Beetle. All enlarged. (After Riley.)

ADULT: The adult is a curculio beetle somewhat larger than the grapecan gill-maker with a dark brown head and a still darker thorax. Each wing cover is marked with three more or less well defined black spots on the edge.

HIBERNATION: The adult beetle hibernates in the ground.

REMEDIES: On account of the inability of this pest to fly—its wings being useless—it is rather readily controlled by plowing out

and burning the plants from the infested fields. Therefore using uninfested plants and locating the patch as far as possible from the old patch will keep this insect from getting a foothold.

STRAWBERRY ROOTWORMS.

The rootworms are the larvæ of three of the very common Chrysommelid beetles in this State. These larvæ are readily distinguished from those of the crown-borer by the fact that they are



STRAWBERRY ROOT-BORER.

(*Typophorus canellus*, Fab.) Adult and larva greatly enlarged. (After Pettit, Mich. Exp. Sta.)

much thicker, more curled, and have three pairs of legs on the thorax. Dr. S. A. Forbes, State Entomologist of Illinois, has well worked out the life history of these pests and we are inserting the following from his thirteenth annual report. "The larva of *Colaspis* appears early in the season, and does its mischief chiefly in the months of April and May, the beetles beginning to emerge in June. That the eggs are laid in the preceding year is highly probable, in which case the species hibernates in the egg. Typo-

phorus, on the other hand, certainly passes the winter as an adult, doubtless laying its eggs in spring, and making its principal attacks upon the plants in June and July, the beetles emerging in the latter part of July and early in August. *Graphops* hibernates in the larval condition, pupating in the spring, and emerges in May and June. The eggs are probably laid in July, and the larvæ make their attack upon the plant in August and September. . . .”

The following is a description of the insects in the order of their economic importance.

Typophorus canellus—Fab.

This insect is only $\frac{1}{8}$ inch long, oblong and oval in shape. It is so variable in color that seven colored varieties are known. The colors range from wholly black to reddish and yellowish, with and without spots on the wing covers—the number of spots varying from one to three on each cover.

Colaspis brunnea—Fab.

This species is slightly larger than the preceding one, but about the same general shape. The legs are of a paler color and the general color of the insect is yellowish, tinged with brown to reddish. It is readily confused with some of the color types of the above species.

Graphops pubescens—Mels.

This beetle is oblong and more slender and cylindrical than the preceding. It is a little less than $\frac{1}{8}$ inch long and of a bronze color and is sparsely covered with pubescence.

REMEDIES: The adults of all three insects are leaf feeders and may be controlled by spraying with 3 pounds of arsenate of lead to 50 gallons of water. Badly infested fields should be handled the same as those infested with crown-borers.

Insects Injuring Currants and Gooseberries.

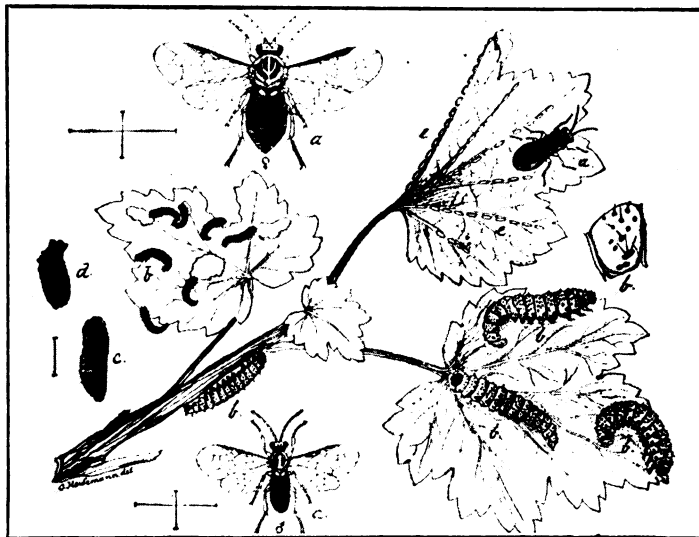
IMPORTED CURRANT-WORM OR SAW-FLY.

Pteronus ribesii—Scop.

This is one of the most common well known insects of the currant and gooseberry and perhaps the most destructive. It begins its work early in the spring by skeletonizing the leaves of the cur-

rants and gooseberries. There seems to be no variety that shows in any degree a resistance to this pest. It was introduced in America in the middle of the 19th century and now is known in practically all locations east of the Rocky Mountains, where its hosts are grown.

EGG: The eggs are laid in rows on the ribs of the leaves. They are small and whitish and hatch from four to ten days after oviposition.



THE IMPORTED CURRANT-WORM.

a) Adults. (b) Larva. (c) Pupa. (d) Pupa cases. (After Lugger, Minn. Exp. Sta.)

LARVA: The larvæ are whitish-green to grass-green in color, depending on the molt. The head is black and the body is covered with black spots during the early instars. The full grown larvæ obtain a length of about $\frac{3}{4}$ inch.

PUPA: The brownish cocoon made of rather tough silk may be found in the ground or among dead leaves beneath the bushes. This contains the pupa, which is almost $\frac{1}{2}$ inch long.

ADULT: Like the strawberry saw-fly, the imported currant-worm is a typical saw-fly about 1/3 inch long.

REMEDIES: See Native Currant-Worm.

IMPORTED CURRANT-BORER.

Aegeria tipuliformis—Clerck.

This is another European pest that has found America more to its liking than its native home. The insect attacks both gooseberries and currants and by tunneling through the canes kills them. In the prominent gooseberry and currant sections of the country it has proved itself to be a very serious pest.

EGG: The eggs, which are laid in late spring in the axils of the leaves, are small, spherical in shape and of a brownish color.

LARVA: Upon hatching the young larva bores into the cane to the pith, in which it works. When full developed it is about $\frac{1}{2}$ inch in length and of a pale yellow color with a brown head.

PUPA: The larva before it passes into the pupa stage cuts a hole for the emergence of the adult and fills it with borings and then pupates. The pupa is shiny, yellowish brown and is about $\frac{3}{4}$ inch long. Empty pupa cases are often found partially extending through the opening through which the adult moth emerges.

ADULT: The adult is a typical clear-winged moth much like the adult of the peach-tree borer, except in size. The moth is of a striped black color with four bright yellowish bands—one around the neck and the other three on the abdomen. The tip of the abdomen is tufted with long hairs and the wings are striped with black.

REMEDIES: The affected canes are distinguished by the withered yellowish appearance of the foliage. These should be cut out and burned as soon as they are discovered.

NATIVE CURRANT-WORM.

Gymnonychus appendiculatus—Hartig.

This form is not so injurious as the European, but its distribution is very wide. It is often found associated with the imported currant-worm. The habits are quite the same as the preceding, but the larva may be distinguished by its uniform dull greenish blue color with a black to partly green head. The larva of this insect is about $\frac{1}{3}$ smaller than the preceding—a characteristic by which it may be readily distinguished. The cocoon—unlike the preceding—is fastened to the stems of the leaves and bushes. The adult saw-fly is black with a yellow head and straw yellow legs. It is somewhat smaller than its European relative, but may be controlled by the same measures as are recommended for the

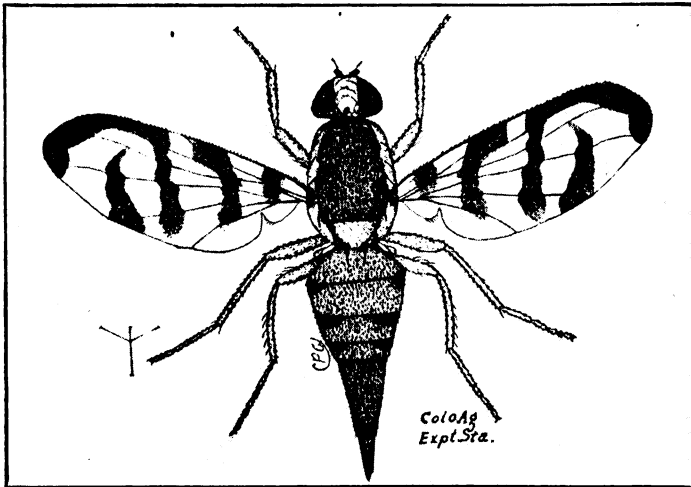
European species. There are two broods of the native currant worm, as is the case with its European relative.

REMEDIES: When the larvæ appear the most practical method of control is spraying with arsenicals. If, however, remedial measures must be taken after the fruit has set, it is advisable to use hellebore, as there would be danger of arsenate of lead adhering to the fruit.

CURRENT FRUIT-FLY.

Epochra canadensis—Loew.

This pest is a member of the same family as the apple maggot and the cherry fruit-fly. It has recently been reported from the northern part of the State by Mr. Morrison, a deputy of this department. In Maine, Colorado and Montana it is almost impossible to grow either currants or gooseberries free from the maggots of this insect. In Montana the entire crop is often lost because of its ravages. The injury is caused by the larvæ boring into the skin of the fruit and feeding on and around the seeds, causing a premature ripening and dropping of the berries.



THE ADULT OF THE CURRENT FRUIT-FLY.

(After Gillette, Colo. Exp. Sta.)

EGG: The eggs are laid singly, just beneath the skin of the berries. A single female deposits from 150 to 200 transparent or whitish colored eggs that are scarcely 1/25 inch long. The eggs hatch from five to seven days after being deposited.

LARVA: This stage resembles very much that of the corresponding stage of the apple maggot. When full grown the larva is more or less glossy, creamy white and about $\frac{1}{4}$ inch long. The duration of this stage is three weeks.

PUPA: The larva when full grown drops to the ground where pupation takes place. The pupæ are very much like those of the apple maggot.

ADULT: The adult fly is yellowish-brown in color with wings banded like those of the cherry fruit-fly. The abdomen is long and tapering making the adult insect about $\frac{5}{16}$ inch long.

HIBERNATION: The winter is passed in the pupal state an inch or so beneath the surface of the soil.

REMEDIES: Chickens are fond of the maggots of the currant fruit-fly and therefore by allowing poultry to run among the bushes good results may be obtained. Fallen fruit should be picked up and burned every few days. The same methods that have been suggested for the control of the apple maggot and cherry fruit-fly should apply also to this insect on account of its striking similarity in habits to them.

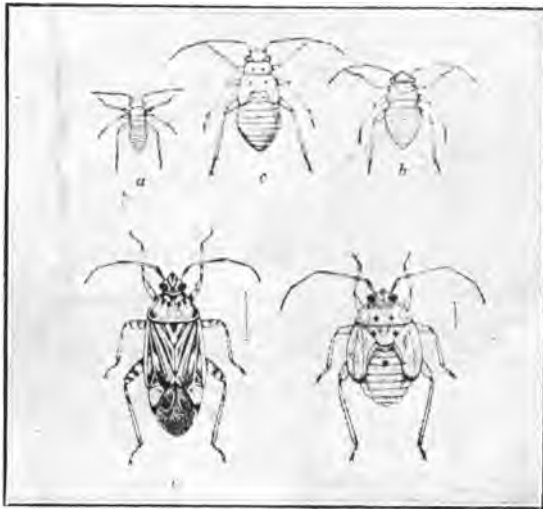
MISCELLANEOUS FIELD CROP AND GARDEN PESTS.

TARNISHED PLANT-BUG.

Lygus pratensis—Linn.

This insect is perhaps the most common of the true bugs (with sucking mouth parts).

Collections of insects made from widely separated points in the State always show a large number of these insects among them.



THE TARNISHED PLANT-BUG. (a), (b), (c) and (d), Early instars. (e) Adult.
(After Forbes, Ills. Exp. Sta.)

On account of its being inconspicuous and small, it has had little blame placed upon it for the great amount of damage it has done, but since its life history has been more closely investigated it has been found to be an exceedingly serious pest. The well known trouble of stop-back of the peach—formerly accredited to a mite—has been shown by Dr. E. A. Back and W. J. Price to be the work of this insect. Professor E. B. Taylor has shown that much of the “dimpling” of apples is caused by egg punctures of this pest and not always by curculios as is usually supposed. The common

“buttoning” of strawberries is attributed to the feeding of this insect. It is a very general feeder and attacks all sorts of garden crops, flowering plants, young trees, shrubs and is very commonly found on the ragweed.

Egg: The eggs are very small, being only about $1/32$ of an inch long and of more or less elliptical shape and tapering at the smaller end. The eggs have been discovered in the apple but have never been observed on any other one of the numerous host plants.

NYMPH: The nymphs are from $1/20$ to $3/16$ of an inch long, depending on the instar. The color is yellowish to olive green and after the second molt they have five blackish spots, four on the thorax and one on the middle of the back. It requires four weeks for the newly hatched, tarnished plant-bugs to reach the adult stage.

ADULT: The fully grown plant bugs are about $\frac{1}{4}$ inch long and are exceedingly variable both in color and markings. The color is dull yellowish-brown to almost black and variously streaked or spotted. The thorax is striped with black.

HIBERNATION: The adult hibernates beneath rubbish, trash, boards, etc.

REMEDIES: Clean cultural methods is perhaps the best preventative measure and will result in a materially decreased number of this insect. Cut and burn the weeds about the place and clean up all boards and rubbish. When the insects are found doing damage on the plants, spray with 10 per cent. solution of kerosene emulsion.

WHITE GRUBS.

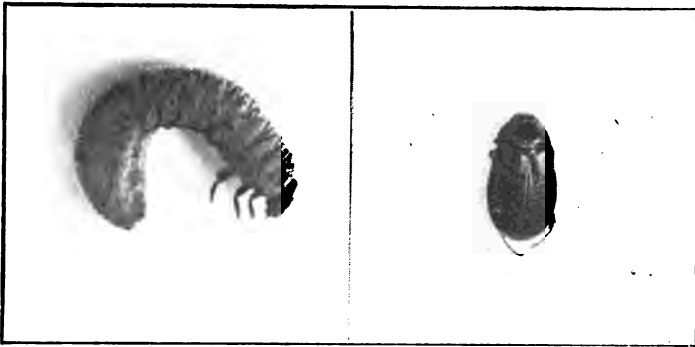
Lachnosterna—spp.

The common white grubs or grubworms are very common in lawns or grass lands and may be seen in great numbers in furrows of newly broken sod. These are the larvæ of the May beetles or June bugs. They feed on the roots of corn, strawberries and all sorts of garden crops. The larvæ of the different species are practically indistinguishable and since it is the larval form that is most commonly known by the casual observer, the whole group will be considered in connection with this discussion.

Egg: The eggs are pure shiny white, ovoid in shape, about $1/10$ inch long. The eggs are laid in the latter part of spring in a ball of earth below the surface of the soil and hatch about fourteen days after oviposition.

LARVA: These are too well known to justify anything more than the briefest sort of a description. The head is large and the body is milky-white. The brown abdomen is thicker at the posterior end than at the head end. The posterior end of the abdomen is often very dark to almost black in color. The length of time that this insect remains in the larval stage is either two or three years. When unearthed by a plow or in any other way they are found curled up in an almost semi-circular manner.

PUPA: In this stage of development they are found in earthen shells about 4 inches beneath the surface of the soil. They are very delicate, whitish in color, and about 1 inch long.



THE LARVA AND ADULT OF THE WHITE GRUB. (Second Annual Report.)

ADULT: The color of the adults range from a blackish to a light yellowish-brown, depending on the age and also the species. They are commonly found flying around the electric street lights in cities or towns. The adults have a great number of host plants and do their feeding at night on the foliage of shade trees, fruit trees, grape vines, etc.

REMEDIES: If hogs or poultry are allowed to run upon newly plowed sod land they will greatly reduce the numbers of this insect. Crows and blackbirds also pick up a great many of the larvæ. Deep plowing and harrowing will break the pupal shell in which the tender adults spend the third winter thus greatly reducing the numbers. Such crops as strawberries, where a great injury is caused by the grubs feeding on the roots of the plant, should not follow a grass crop. Instead, the grass crop should be followed by some other crop before strawberries. Garden vegetables in general should be planted.

WIREWORMS.

Family *Elateridæ*.

These are the larvæ of the little brown click beetles, so called because of their habit of flipping up in the air if laid on their backs. During the past season we have had numerous reports of wireworm injury to potatoes and peony roots. Often these "worms" bore into seed corn or wheat after it is planted, killing it and making reseeding necessary. The life history is like that of the white grubs, but as yet has not been thoroughly worked out.

EGG: The eggs are laid in old sod land.

LARVA: The wireworms are usually about an inch long and when full grown are very slender. They are rather hard, glistening, light brown creatures and to the casual observer look very much alike; yet by the scientific men they are readily distinguished by the shape of the last caudal segment of the abdomen. The insect remains in the larval stage from two and one half to four and one-half years.

PUPA: The yellowish colored elongated pupæ are found in earthen cells, very much like the preceding forms, during the summer between the second and fourth years of the insect's life. Emergence from the pupal condition takes place in about one month, but the adult does not come out from the soil until the following spring.

ADULT: These are called click beetles because the habit (which has been mentioned before) is the result of a peculiar joining of the thorax to the abdomen and by a spine on the thorax which works with internal muscles to produce a sort of a spring. The color is from brown to black and is variously marked, depending upon the species. The size also depends upon the particular species.

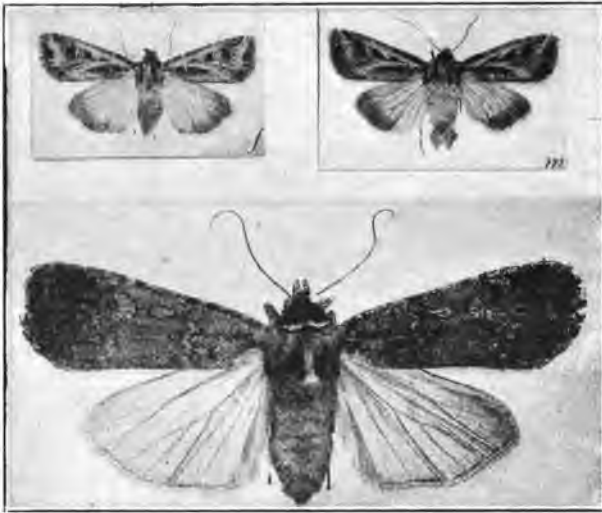
REMEDIES: The remedies for this pest are practically the same as those for white grubs. Perhaps no other measure is so efficient as late summer or early fall plowing.

THE CUTWORMS.

Family *Noctuidæ*.

The cutworms are the larvæ of a family of dark colored and variously marked moths. They are therefore true caterpillars. Because of the fact that so many people mistake the work of the

white grubs and the wireworms for that of the cutworms, it is often very hard to recommend a treatment unless specimens be sent to the office for identification before a recommendation is made. The main purpose of giving a brief life history of the various pests is to enable the farmer to determine at least the family to which the insects causing him trouble belong. The injury caused by cutworms is noticed most especially on young corn, wheat, cabbage, tomatoes, beans, peas and garden crops in general. They are very ravenous feeders and usually do their destructive work under the cover of night and hide during the day at the base of the plant on which they feed. On cabbage, corn, etc., they have a habit of eating off the stems, just at the surface of the ground, causing a wilting and drying up of the plant.



THE ADULTS OF TWO COMMON CUTWORMS (Slingerland).

The well-marked Cutworm Moth (*Noctua clandestina*, Harris). The Dingy Cut worm (*Feltia subgothica*, Haworth). (m) male, (f) female.

EGG: The eggs are laid from the middle to the latter part of the summer in patches on the leaves and stems of grasses or weeds or any other available vegetation. The individual eggs are fantastically sculptured.

LARVA: The young caterpillars hatch in early fall and feed on the roots of plants on which the eggs were laid. The larvæ are typical caterpillars with sixteen legs (three pairs of true legs on the thorax just behind the head and five pairs of prolegs on the

abdomen). This together with the color will distinguish them from the wireworms and the white grubs. The body is thick and cylindrical with a more or less greasy appearance. It is of a dark green, dingy brown or gray color, variably marked, spotted or striped. The full grown larva is from 1 to 2 inches long with a dark brown head. The duration of this stage is about six months.

PUPA: The pupa, which is about 1 inch long, is usually of a bright yellowish or reddish-brown color, depending on its age. It may be found in earthen cells from 3 to 6 inches below the soil. It remains in the pupal condition for about one month.

ADULT: The adult moths are night flyers and feed on nectar. The front wings are variable in color—either a dark dull brown, yellowish-brown, reddish-brown or gray—marked with dark or light spots or bands, depending upon the species. The hind wings are of a uniform lighter color with the edges often slightly darker than the remainder of the wing.

HIBERNATION: The half grown larvæ pass the winter in cells below the frost line in the soil.

REMEDIES: Late fall or early spring plowing is quite effective if poultry is allowed to follow along behind the plow and pick up the larvæ. Clean cultural methods and early plowing under of the weeds to prevent the moths from laying eggs on them is important. Poison bran-mash has been found effective in destroying this pest. It should be applied in infested fields in late afternoon several days before the plants are set. When seeds are used instead of transplants, the poison mash should be applied at seeding time. Market gardeners and florists protect their newly set plants, such as cabbage, tomatoes, asters, etc., with tin or paper cylinders sunk into the soil around the stems of the plants. A good type of tin cylinder for this purpose may be made by taking the bottom off of an ordinary tomato can, and where only a small number of plants are to be protected this method is perhaps the most practical.

TOMATO SPHINX.

Phlegethontius sexta—Johannsen.

The distribution of this insect is very great and on account of its being such a large larva and having a more or less terrifying appearance, numerous requests come to this office for remedies. This insect is very closely related to the tobacco worm and the life history and control of both is practically identical. The tomato



TOMATO SPHINX. (a) Pupa (b) Adult. (Second Annual Report.)



LARVA OF TOMATO SPHINX (*Phlegethontius sexta*).

Larva and Parasitized larva, showing the pupa cases of the parasite. (Second Annual Report.)

sphinx is commonly found feeding on tomatoes, potatoes and other members of the Solonaceæ family, and tobacco.

EGG: The eggs are laid singly on the under side of the leaves, from which the larvæ hatch in from four to six days. They are about $1/25$ of an inch in diameter, pale green in color and spherical in shape.

LARVA: The tomato sphinx in this stage of development is deep green in color with seven white simple oblique stripes on each side of the body. The length is from three to four inches and like all typical sphinx caterpillars, the larva has a prominent reddish spine or horn near the posterior end of the abdomen. Although it is commonly supposed that the caterpillar stings with this horn or spine, it is absolutely harmless and may be handled with impunity. The duration of this stage is about three weeks.

PUPA: The pupa is deep brown in color and about two inches long. It is found in an oval cell from four to six inches below the surface of the soil. It remains in this condition about three weeks before the adult moth emerges. The pupæ of this group of moths are characterized by having a peculiarly handle-shaped process at the head end. This structure is often referred to as a jug handle.

ADULT: The front wings of the adult moth are brownish-gray, marked with black. The hind wings are marked with three more or less distinct white bands. The abdomen has six large, bright, orange-yellow spots on each side. The wing expanse is nearly four inches, but the length of the body is only about half that much.

REMEDIES: It has been demonstrated by Prof. A. C. Morgan, of the Alabama Experiment Station, that the pupæ die in the pupal cell when the latter is disturbed. Hence, plowing and thorough harrowing in late fall will destroy the hibernating pupæ. Hand picking and spraying with arsenicals will be effective against the larvæ.

THE STRIPED CUCUMBER-BEETLE.

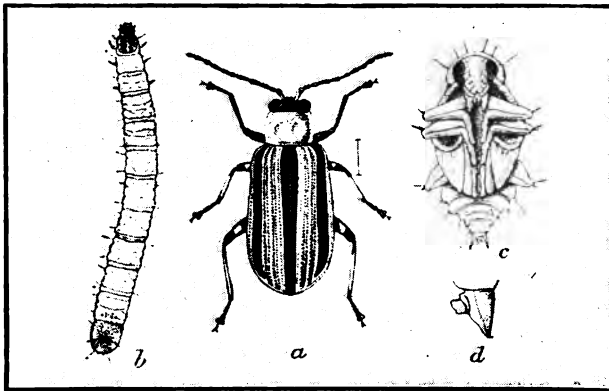
Diabrotica vittata—Fab.

This little beetle is perhaps the worst pest of squashes, melons and cucurbitaceous plants throughout the State. Although it is very common, there are many people who do not know how to combat it. It is a voracious feeder and as it is particularly fond of the young plants, it often kills out the entire patch, making replanting necessary.

EGG: The eggs, which are oval in shape, yellow in color and about $\frac{1}{40}$ inch long, are laid singly in the cracks in the soil. A single female deposits about one hundred eggs, which hatch in about a week.

LARVA: The larvæ are a little more than $\frac{1}{5}$ inch long, somewhat resembling small wireworms, only being white in color with head and last segment dark brown. The first segment behind the head is slightly lighter in color than the head itself. The young larvæ bore into the roots of plants and the latter often wilt and die as a result of this work. This stage lasts about one month.

PUPA: The pupa, which may be found in an earthen cell, is delicate and white.



THE CUCUMBER-BEETLE.

(a) Adult, (b) larva, (c) pupa, (d) egg. (After Chittenden, U. S. Dept. of Agr.

ADULT: It is in this stage that the insect is most commonly known and in most cases the adults do the greatest amount of damage. The beetles are a little less than $\frac{1}{2}$ inch long and about half as wide. They are of a lemon-yellow color with three black stripes on the back and with a black head.

HIBERNATION: Any available shelter on or near the feeding ground furnishes a place for the adults to pass the winter.

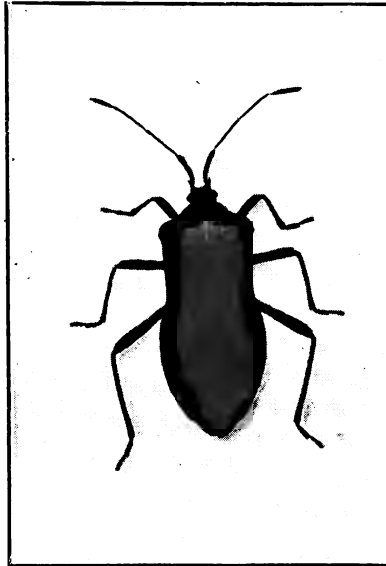
REMEDIES: Covering the hills over with a dome-shaped screen, or any sort of a mosquito netting is very practical for small areas (and may also be used to advantage in large areas) and will prevent the adults from getting in their injurious work while the plants are small and tender. Planting such crops as beans or squash earlier than the regular crop is planted serves very well as a trap crop,

This used in connection with keeping the regular crop dusted with some substance such as air-slacked lime, tobacco dust or pyrethrum, will result in a very effective control of this pest. Perhaps the best remedy is to spray the plants with arsenate of lead, about three pounds to fifty gallons. This must be done thoroughly, as the beetles will feed on the areas of the leaves that are not reached in case thorough work has not been done.

SQUASH-BUG.

Anasa tristis--DeG.

The black squash-bug or stink bug, as it is commonly called, is too well known to Indiana growers of cucurbits to need much of an introduction. This form causes injury to squash, cucumbers and



THE ADULT OF THE SQUASH-BUG. Enlarged about $2\frac{1}{4}$ times. (Original.)

melons in three ways: First, by sucking the juices of the plant; second, by injecting into the plant saliva which poisons the cells and causes the wilting and drying up; and, third, by carrying the melon blight bacteria. This is one of the most injurious pests that attack cucurbits.

Egg: The eggs are comparatively large and being a pale yellow-brown to a dark brown color—depending on the age—and also

being laid in groups on the under side of the leaves are readily found by a careful search. The groups contain from a half dozen to a dozen and a half eggs. The individual eggs are about one-sixteenth of an inch long and more or less oval in shape. The incubation period is about two weeks.

NYMPH: The newly hatched nymphs are very highly colored at first with crimson and green—the crimson soon turning to black. The young bugs resemble the adult more or less in shape, but the wings are lacking. The duration of this stage is from a month to six weeks, during which time there are five molts. The length of the nymph is from $\frac{1}{3}$ to $\frac{1}{2}$ inch.

ADULT: The full grown squash bug is about $\frac{3}{4}$ inch long, with wings of a dirty blackish brown color. The under side of the abdomen is tinged with yellow and the upper side is striped transversely with yellowish bands. When at rest the wings are folded across the back, leaving a triangular space between them.

HIbernATION: Adult squash-bugs pass the winter under dead vines, rubbish, etc.

REMEDIES: Very good results may be obtained by laying boards near the food plants of this insect and collecting the bugs from under them by hand early in the morning. When cucumbers and melons are the main crop, planting a trap crop of squash is recommended. The nymphs may be killed by spraying with kerosene emulsion. This, however, is not effective against the adult. Picking off and burning the egg masses will prevent a large infestation of nymphs and raking up and burning the dead vines in the fall will prevent a large number of adults from successfully hibernating.

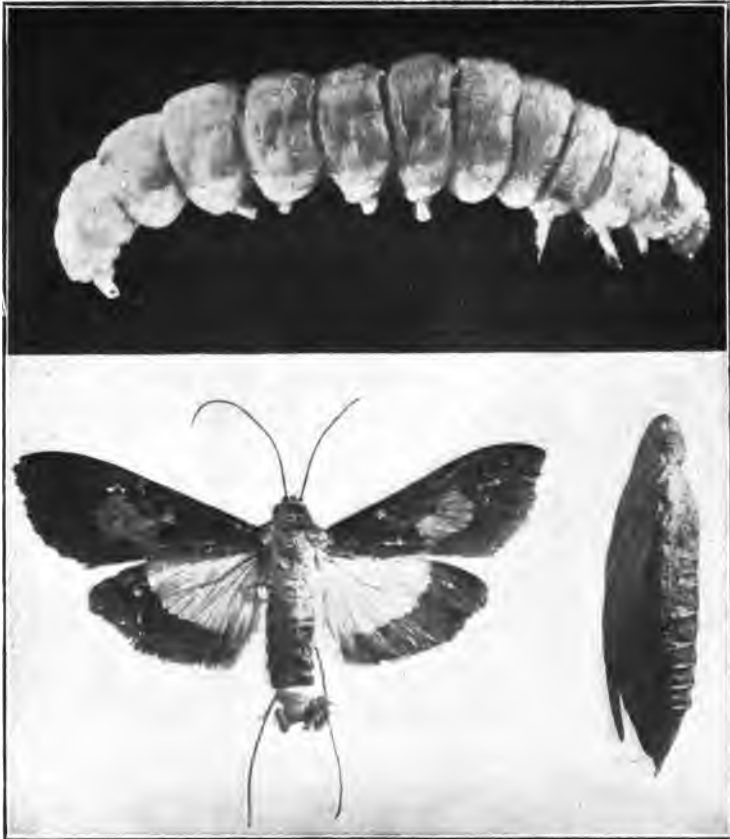
PICKLE WORM.

Diaphania nitidalis—Cramer.

This is a Southern pest that seems to have worked its way northward. In the vicinity of Corydon, Indiana, it has been particularly injurious to squashes and melons, especially by boring into the mature fruit, making it practically worthless. Some damage has been found as far north as Indianapolis and there is no doubt about the pest being well established in several regions of the State.

Egg: The eggs are little larger than $\frac{1}{32}$ of an inch long, elliptical in shape and of a very pale yellowish color. They are laid in groups of from three to eight on the younger shoots, buds or flowers of the food plant.

LARVA: The larvæ are very typical lepidopterous forms. In the younger stages (i. e., until about half grown) they are very pale yellow in color with brown heads and abdomens marked transversely with rows of black dots. When full grown the larvæ are pale yellowish-green or nearly white, with head and



THE PICKLE WORM.

Upper figure shows the larva; lower right-hand figure, the pupa; lower left-hand figure, the adult moth. (After Quaintance, Georgia Exp. Sta.)

prothoracic shield brown. The length of the full grown larvæ is about three-quarters of an inch. At first they feed in the proximity of the eggs, but later get a wandering habit and finding the fruit, bore into it. Their presence is told by the excrement that pushes out at the opening of the cavity. The duration of the larval stage is about fourteen days.

PUPA: The fully developed larvæ come out from within the fruit and pupate within a folded leaf. The pupa is about $\frac{1}{2}$ inch in length, brown in color, with a somewhat lighter color on the ventral side. The abdomen at the posterior end has short curved spines.

ADULT: The general color of the body and the wings of the adult is a yellowish-brown with a purplish tinge when brought into the light. The front wings are marked with irregular yellowish spots in the middle. The hind wings are about $\frac{2}{3}$ yellow, bordered with a darker colored band. There is a prominent brush-like structure at the tip of the abdomen which is not made up of hairs, but of modified scales. The wing expanse is about one and a fourth inches.

HIBERNATION: The winter is passed in the pupal stage near the food plants. The pupæ are often found attached to weeds, etc., in melon fields.

REMEDIES: Destroy all weeds, rubbish and any shelter that the larvæ might find under which to pass the winter. Plant trap crops of squash and destroy flowers, stems, etc., containing the larvæ. This will protect the main crop of the other cucurbits.

TOMATO WORM.

See Corn Ear-Worm.

MELON APHIS.

See Aphids.

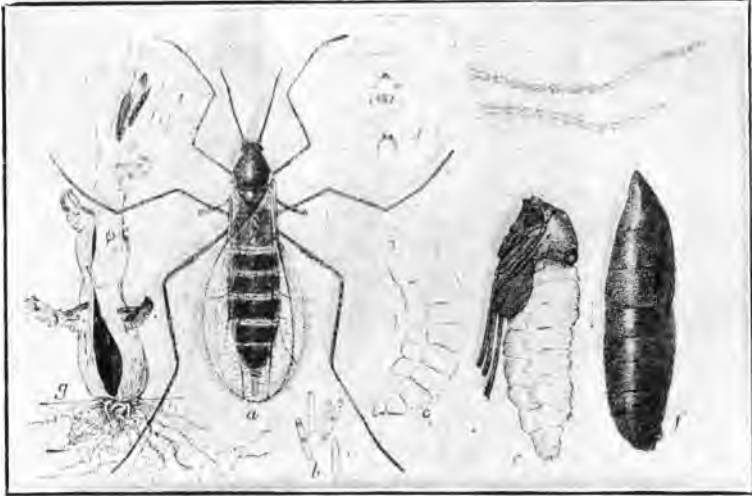
HESSIAN FLY.

Mayetiola destructor—Say.

Although this pest has been known since 1779, and although much literature has been published about its habits and control, we regularly find farmers of the State suffering losses through its depredation. The great loss suffered by the farmers is largely caused on account of their neglect in learning the best methods of avoiding injury from this pest. For this reason, we are including a short account of the insect, together with control methods.

Egg: The small eggs, only about $\frac{1}{16}$ inch long, are laid in irregular rows of from 3 to 6 and sometimes more on the upper surface of the leaves. Each female lays from 100 to 150 eggs in the course of her existence. The eggs hatch in from three to five days.

LARVA: At the beginning of the larval period they are of a reddish color, gradually changing to white. They are cylindrical in shape, and like the larvæ of the typical flies, are without a true head and legs. The full grown larvæ are about 3/16 inch long. They burrow beneath the sheath and cause slight enlargements, and the infested plants "stool" early and the central stems are lacking.



THE HESSIAN FLY.

(a) Adult. (b) "Flax Seed" stage or Puparium. (c) Larva. (d) Head and breast bone of same. (e) Pupa. (f) Puparium. (g) Infested wheat stem showing emergence of pupæ and adults. (After Marlatt, U. S. Dept. of Agr.)

The maggots of the spring brood attack the laterals and so weaken them that the stems break, causing great difficulties in harvesting. The larval period lasts about one month.

PUPA: The insect pupates within the cast off larval skin and this stage is commonly known as the "flax seed" stage of the "fly." The summer brood emerges from this stage in early fall and attacks early planted wheat. This stage is the one best known to the casual observer.

ADULT: The full developed fly is a small gnat about 1/10 inch long. It is of a dark color and not readily recognized because of the hosts of similar little flies that might be mistaken for it.

HIBERNATION: The fall brood goes into the "flax seed" stage from which the adults emerge about the latter part of April or early in May.

REMEDIES: Late sowing of grain is the best method of expiating injury of this pest. From Prof. F. M. Webster's experiments in the U. S. Department of Agriculture, Bureau of Entomology, we believe that any time after the 25th of September will be safe in the northern part of the State and any time after October 10th in the southern half. The proper time, however, must be determined by the individual farmer from his knowledge of the amount of



THE PUPARIA OR "FLAX-SEED" STAGE OF HESSIAN FLY ON YOUNG WHEAT.

(After Pettit, Mich. Exp. Sta.)

growth that can be produced in the fall after sowing. The wheat should be put in as late as possible—due allowance of course being given for the development of a strong root system to stand the winter conditions.

Rotation of crops, plowing under all volunteer wheat plants, or planting a trap crop, are practical. Anything that will keep the wheat growing vigorously is also of importance in overcoming injury.

ONION THRIPS.

Thrips tabaci—Lind.

This pest, in connection with the two onion maggots, has been doing considerable damage in the large onion fields in the northern part of Indiana. The injury is caused by the insects chewing off the skin of the leaves, causing them to dry out, turn white and die. The unusually moist season this year produced a rather unfavorable condition for thrips and consequently no great amount of damage was done by this pest. The previous summer (1911), however, was an ideal one for the development of thrips.

EGG: The eggs are too small to be seen by the naked eye, as they are less than 1/100 inch in length. They are bean shaped and deposited just beneath the surface of the leaf.

NYMPH: The color of the nymphs is from transparent to pale green, depending upon their age. They resemble the adults in form, except that wings are lacking.



THE ADULT OF THE ONION THRIPS.

Very greatly enlarged. (After Quaintance, Fla. Exp. Sta.)

ADULT: The adult thrips is about 1/25 inch long, of a dusky color, tinged with yellow. The wings are very delicate and lie down the back of the insect when it is at rest. They are fringed on all margins with bristle-like hairs. Mouth parts are like those of the pear thrips.

REMEDIES: For control measures, see pear thrips.

IMPORTED ONION-MAGGOT.

Pegomyia ceparum—Bouché.

This pest, along with the barred-winged onion-maggot, has done a great deal of damage in the onion section in the northern part of the State. Dying onions, if dug up, will show wilting and decay, caused by the white maggots boring in the roots and bulbs. This species is a native of Europe and like the cabbage butterfly, brown-tailed moth, and many other very injurious insects that have been introduced causes more serious damage here than in its native home.

EGG: The eggs are usually laid in the axil of the leaves of the young plants. They are about $1/25$ inch long, whitish and ovoid. From 1 to 6 are laid on a single plant.

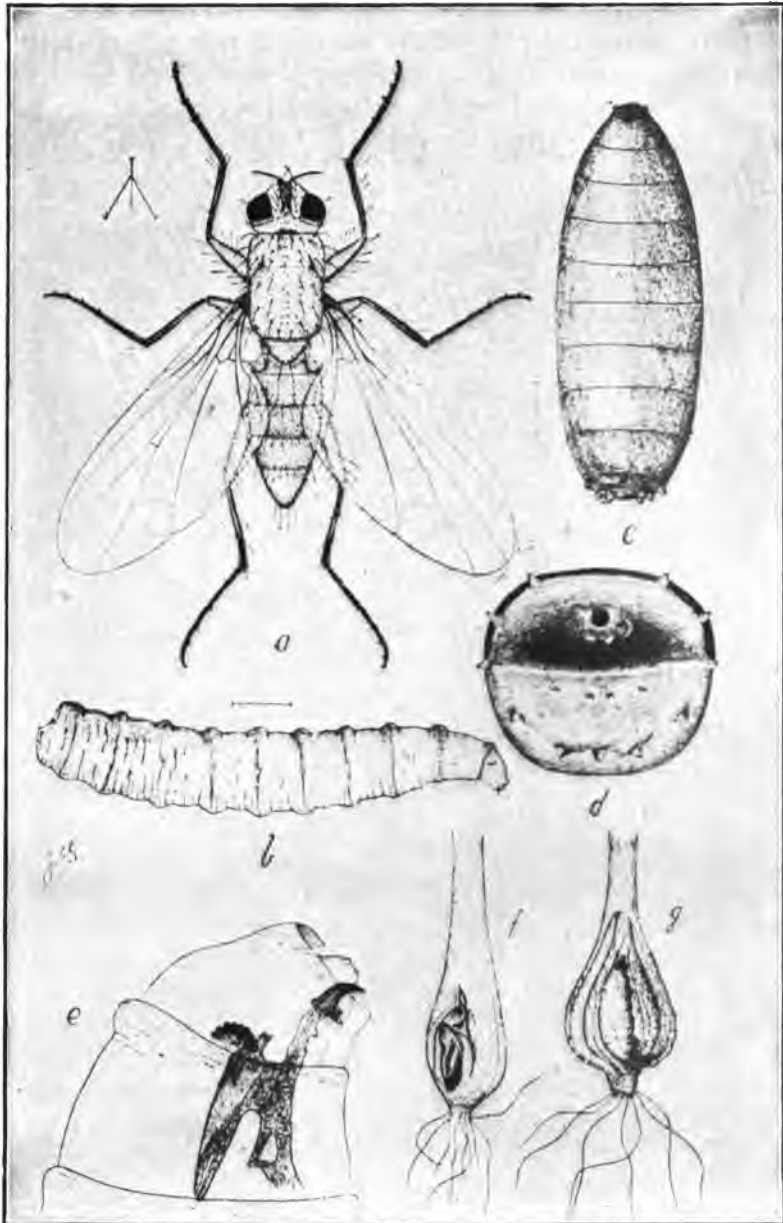
LARVA: It is in this stage that this pest does the damage. The maggot somewhat resembles the house-fly maggot in general appearance, and when full grown is nearly $\frac{1}{2}$ inch long. It is of a chalky white color, with the anterior end pointed and the posterior end cut off rather obtusely, making the larva appear more or less cone shaped. There appears to be a small blackish stripe at the head end, which is merely the jaws of the insect showing through the skin. The injury is caused by the larva boring into the bulbs. As many as $\frac{1}{2}$ dozen may be located in a single bulb. Onions thus infested die in the field or rot when stored. The presence of maggots in the field may be readily detected by the slimy exudation at the entrance of the burrow. The duration of the larval state is about two weeks.

PUPA: The pupal stage is spent within the larval skin—pupation taking place in close proximity to the plant instead of inside it. The pupa is brown in color and about $3/8$ inch long.

ADULT: The adult of the onion-maggot is a fly which has a wing expanse of about $3/8$ inch, and body length of about $3/16$ inch. It is grayish to yellowish in color, depending upon the sex. The bristles and hairs upon its body are black. The face is white to yellowish and three dark colored lines are distinguishable between the wings. On the whole, the adult of the onion-maggot bears very close resemblance to a small house fly.

HIBERNATION: The winter may be passed either in the adult or pupal state.

REMEDIES: Frequent cultivation and application of fertilizers to induce growth is of great importance in overcoming injury by



THE IMPORTED ONION-MAGGOT.

(a) Adult. (b) Larva. (c) Puparium. (d) Anal segments of maggot showing breathing processes. (e) Head, with mouth parts. All very much enlarged. (f and g) Showing injury to young onions.

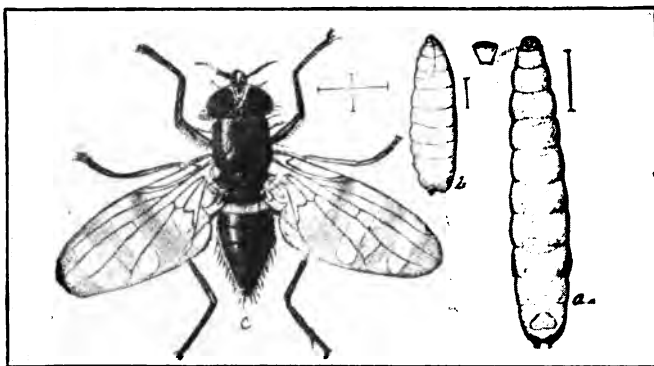
(After J. B. Smith, N. J. Exp. Sta.)

these pests. An application of carbolic emulsion seems to act as a repellant, but nothing as yet has been used that will completely control this insect. Rotation of crops, of course, will assist materially. Perhaps the foremost method in the control of this pest is fall plowing to destroy the pupæ.

BARRED-WINGED ONION-MAGGOT.

Chaetopsis aenea—Wied.

This form is also doing considerable damage in the onion fields in the northern part of Indiana. The adults are about the same size as those of the preceding species, but bear some resemblance to the green bottle fly, being of a shiny, bluish-green. The head is



THE BARRED-WINGED ONION MAGGOT.

(a) Larva. (b) Puparium. (c) Adult. All enlarged. (After Riley and Howard, U. S. Dept. of Agr.

white in color and the eyes are rather dark. The wings are banded with black. The maggots of the barred-winged onion-maggot are distinguished from the preceding by the more rounded posterior end. The life history is practically the same as that of the imported onion-maggot, except that it has been noted that hibernation takes place only in the pupal stage, thus simplifying control measures. But as both species occur together in northern Indiana, the remedies given under the preceding will apply also to this form.

CORN EAR-WORM.

Heliothis obsoleta—Fab.

This form is working great injury to sugar corn and field corn in the State and besides this is doing considerable damage to tomatoes, peas and beans. Its list of food plants is long and its

damage extensive. It is found in practically every locality in the State and is called the corn ear-worm because of its habit of working into the ears, usually at the tip. In occasional instances, however, it will bore through the husks and attack the ear about the middle.



THE CORN EAR-WORM, SHOWING THE LARVA AND ITS WORK. (Original.)

Egg: The eggs are laid in the spring on any food plants that happen to be at hand. The moths of the later generation, however, lay their eggs almost universally on the silk of corn. The eggs are

about 1/16 inch in diameter, of a pale yellow color and artistically ridged. They resemble a sphere that has been flattened on one side. The incubation period is from three to five days.

LARVA: The markings of the larvæ are very variable. The color ranges from plain colors to markings with stripes or spots. When full grown they are from about 1 to 1½ inches long. The larval period extends over a period of sixteen or eighteen days.

PUPA: In this state the insect is almost an inch long and of a bright reddish-brown color. The pupa may be found in a long cell from 1½ to 6 inches in length. The top of the cell is just beneath the surface of the ground so that the adult may readily emerge. The duration of this stage is from twelve to fourteen days.

ADULT: The adult, as in the case of the larva, is very variable—the color ranging from olivaceous to yellowish-brown or cream color. The markings vary considerably, some moths being very plain. In rather typical specimens the wings are edged with dark colored bands, with veins rather blackish, and the front wings variously marked with black. The wing expanse is about 1½ inches.

HIBERNATION: Winter is passed in the soil in the pupal state from which the moths emerge late in the spring.

REMEDIES: If the infested fields are plowed in late fall to break up the pupal cells, great mortality will result. Early planting of corn will be more or less effective, as the moths prefer the corn to be in "silk" when they lay their eggs. Growing beans in or near the corn should be avoided, as this will increase the number of adults in the vicinity of the cornfield.

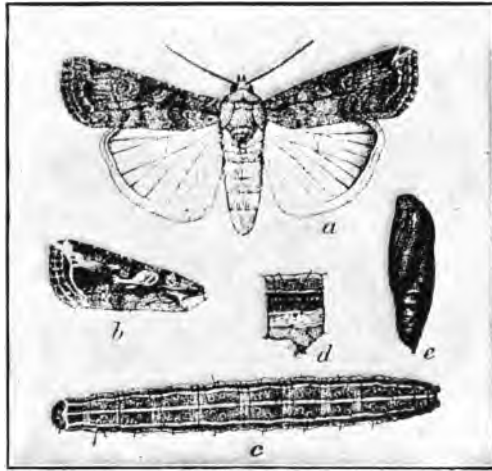
FALL ARMY WORM.

Laphygma frugiperda—S. and A.

Serious outbreaks of this pest have occurred in two localities this season about the first of September—one near Broad Ripple and the other in the southern part of the State. As its name implies, this species appears much later in the season than the real army worm, which seldom becomes injurious after the latter part of July. The fall army worm is a very general feeder, eating not only grass, but also a great many of the forage and truck crops. There are three more or less complete broods of this insect in the State, the southern part, of course, having three broods, while the northern portion seldom has more than the second brood.

EGG: The eggs are sometimes laid in masses on the food plants of the larvæ, but usually they are deposited in a cluster of fifty or more upon the grass. The adult female covers the mass with the silvery gray hairs from her abdomen. The eggs hatch from ten days to two weeks after oviposition.

LARVA: The caterpillar stage resembles the true army worm, but is distinguished from it by two blackish longitudinal stripes on each side of the body. The stripe down the middle of the back is



FALL ARMY WORM.

(a) Gray form of moth. (b) Forewing of a variable form. (c) Larva. (d) Segment of larva, side view. (e) Pupa, enlarged about one-fourth. (After Chittenden, U. S. Dept. of Agr.)

gray and twice as wide as those on the sides. There are four black dots on each segment, or within this grayish band. The number of hosts upon which this caterpillar has the habit of feeding is not so large as those of the regular army worm.

PUPA: This form is about $\frac{1}{2}$ inch long and dark brown in color. It may be found in the ground just below the surface of the soil.

ADULT: The adult moth is of a grayish yellow color with a wing expanse of $1\frac{1}{4}$ inches. The front pair of wings are mottled in the central part. This mottled appearance may extend more or less over the entire area of the front wings.

HIBERNATION: The fall army worm hibernates just below the surface of the soil in the pupal state.

REMEDIES: Where the "worms" are present in moderate numbers, poisoned bran-mash or spraying the food plants with arsenicals

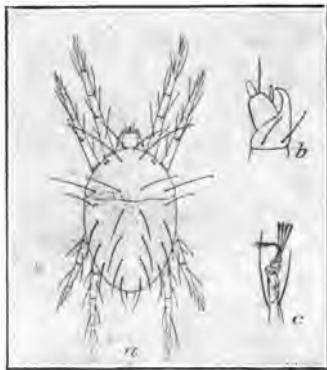
may be used successfully. When they occur in great numbers, however, a better method of control is to make a dust furrow around the infested area and when the caterpillars become massed in this furrow, spray them with kerosene.

Deep fall plowing to crush the cells of the hibernating pupæ causes great mortality among them, thereby reducing the number of adults that would otherwise emerge in the spring.

RED SPIDER.

Tetranychus bimaculatus—Harvey.

This pest is not an insect, but belongs to the Arachnida, the same group as do the spiders. It is not, however, a true spider but belongs to the spinning mites. It is the same pest that is so com-



THE RED SPIDER.

(a) Adult. (b) Mouth parts. (c) Claws. All greatly enlarged. (After Chittenden, U. S. Dept. of Agr

monly found in greenhouses. These mites spin very fine webs on the underside of the leaves, which can scarcely be noticed with the naked eye. The web is not used in climbing, as is the case in true spiders, but rather as a protection within which they feed on the tissues of the leaves. Numerous Norway maples, soft maples, linden, horse chestnut, and many other species of trees in Indianapolis have been seriously affected by this pest. The damage produced has caused many of the trees to shed their leaves before the close of summer and to burst again into leaf only to be nipped by the frost. The danger of permanent injury to the trees is thus increased, especially if the following winter should be severe.

Egg: The eggs of the red spider are almost spherical in shape and microscopic in size. Their size varies a little and they appear

under the microscope like little oil globules scattered around on the web and surface of the leaf. The young red spiders, called nymphs, resemble the adults, except in size and by the fact that they have only six instead of eight legs. The color ranges from whitish to a rather yellowish orange.

ADULT: The adult red spider is oval in shape and very tiny. It is hardly visible to the naked eye, as it is only 1/100 to 1/50 inch in length. The color is reddish or orange red with a dark spot on each side. On the legs and body may be found a number of heavy bristles. The mouth parts are fitted for sucking the juice of plants.

HOST: Red spider is found on practically all greenhouse plants, violets and roses being particularly susceptible to its attacks. Garden crops, such as beans, cucumbers, muskmelons and squashes, are often injured. Among the shade trees that are most commonly affected are the Kentucky coffee tree, maples, horse-chestnut, birch, linden, arbor vitæ and drooping mulberry.

REMEDIES: Flowers of sulphur mixed with strong soap suds, at the rate of one ounce of sulphur to one gallon of solution, is very effective. In cases where the plants are injured by the sulphur, plain strong soap suds may be used. Kerosene emulsion or "Black Leaf 40" (Nicotine sulphate) has produced good results against this pest. In spraying for the red spider care must be taken to cover the under side of the leaves thoroughly in order to bring the spray material in contact with the pest.

INSECTS THAT AFFECT THE HOUSEHOLD AND MAN.

BY HARRY F. DIETZ.

So many calls have been made concerning the household insects during the past year that we have decided to devote a chapter in this report to the more important insects that affect the home and man. Foremost of all we would place the typhoid fly and some of its nearly related allies, the biting stable fly, the blue bottle fly, and the blow flies. Next, of course, would come the mosquito. All these insects are well known carriers of disease and any one who knows their general habits can readily see the great danger to which human life is daily exposed. Consequently, too much stress cannot be laid on the motto, "Swat that Fly or Kill the Mosquito." The housewife cannot be too careful in keeping the place clean, for it is not to be supposed that flies and mosquitoes are the only carriers of disease. In California it was demonstrated that rat fleas carry bubonic plague; in Montana it was shown that Rocky Mountain Spotted Fever could be transmitted by the bedbug; and in Mexico the late Dr. H. T. Ricketts gave his life to prove that it was the bite of an infected body louse that is the cause of typhus fever. Though these diseases do not occur in Indiana it is probable that such insects as mentioned above are concerned with the spread of some of our common infectious diseases.

The other insects herein listed are arranged in the order in which they seem to have been most important during the past year. The termites, or white ants, are making serious inroads in floors and furniture, and have even gotten into wooden walls. There is thus danger that they will get into the wooden supports of buildings, and since they work unnoticed they might cause the collapse of the structure before any danger might be suspected. Fleas, owing to the particularly favorable season, have been unusually plentiful in the northern part of Indianapolis, and have been a cause of much alarm among the housewives returning home from their vacations at the Lakes or in the country. The other insects mentioned are all common household pests, though their life history is little understood by those who have not made a special study



FLIES ON AN ATTIC WINDOW. (Third Annual Report.)

of it. Since the only way to successfully combat any insect pest is to know its habits and life history so that remedies may be used with reason, we have gone into detail on these points.

TYPHOID FLY.

Musca domestica—Linn.

Everyone knows the typhoid fly as it has recently been called, but perhaps does not distinguish it from some of the other common flies that occur with it. This perhaps is a matter of no great importance, for 95 per cent. of all the flies in the house are the true house or typhoid fly, and the habits of all house-infesting flies are more or less alike. The typhoid fly does not bite, as is sometimes supposed; this is another species, the biting stable fly (*Stomoxys calcitrans*—Linn) which is probably the transmitter of infantile paralysis. The house fly's or typhoid fly's feet are covered with hairs and filth. They may be found eating in garbage cans, stables or vaults one minute and the next found walking on some man's bread and butter or drinking from his milk or soup.

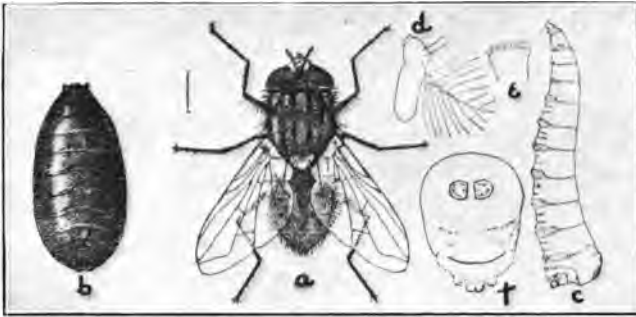
It is therefore positively dangerous to allow the typhoid fly access to the house, for it has been demonstrated time after time that its feet are swarming with bacteria among which the organisms of typhoid, diarrhea, dysentery, consumption and other diseases have been isolated.

EGG: The eggs of the fly are laid on decaying matter of all sorts, but preferably on horse manure. They are white in color, more or less elliptical in shape and about 1/20 of an inch in length. When highly magnified, they greatly resemble a grain of wheat. The time of hatching of the eggs is extremely short, varying from five to twenty-four hours after they are laid.

LARVA: These are the common maggots found in garbage cans or in decaying refuse. When full grown they are about 1/3 inch in length, conical in shape, that is, pointed at one end and blunt at the other. The pointed end is the head. The color is a yellowish white. The duration of the larval stage varies from five to twelve days, depending largely on the temperature.

PUPA: The pupa is formed within the larval skin, which turns brown and becomes more or less wrinkled. The pupa within is soft and white and the duration of the pupal stage is quite variable, depending very much on the weather and temperature. It ranges from five to nine days.

ADULT: The adult is a very familiar object and hardly needs a description. It is $\frac{1}{4}$ inch long and of a dull gray color, with the thorax and abdomen streaked with blackish. The body and legs are well covered with minute hairs, among which heavy bristles are dispersed, especially on the thorax and abdomen. The mouth parts are blunt and are adapted only for sucking or lapping and cannot be used for piercing, as is commonly supposed.



THE HOUSE FLY.

(a) Adult. (b) Puparium. (c) Larva. (d) Antenna of adult. (e and f) Enlarged parts of larva.
(After Howard, U. S. Dept. of Agr.)

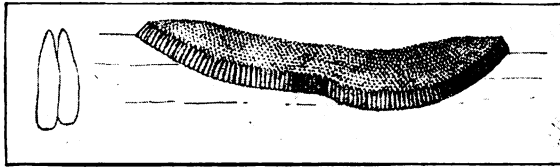
HIBERNATION: Hibernation takes place in the adult stage. Only a few adults survive in out of the way places during the winter, but these are sufficient to build up the depleted fly population the next year, especially in warm weather, when the complete life cycle takes only two weeks.

REMEDIES: Keeping things clean is, of course, the best method of controlling the typhoid fly. The garbage cans should be tightly covered and all refuse should be kept in containers to which the flies cannot gain access. This will prevent the laying of eggs which, of course, will be a great help, when it is realized that a female fly lays a large number of eggs in her lifetime. Stable manure should be thoroughly cleaned up daily and kept in dark, tightly screened rooms, while air slaked lime should be well sprinkled about.

Keeping the house well screened and using both sticky and poisoned fly papers will be effective in keeping the house free from this pest. In ridding badly infested rooms of flies, Prof. Z. P. Metcalf has recommended that pyrethrum, better known as Persian Insect Powder, should be burned. This gives off a dense white smoke, which is perfectly harmless to man, but which stupifies the flies so that they fall to the floor. They must then be swept up and burned.

MOSQUITOES.

The discovery that both malaria and yellow fever was carried by mosquitoes excited an active interest in the study of these injurious insects and even the layman has come to understand the importance of insects as carriers of disease through these examples. If nothing else, mosquitoes are a nuisance and methods of getting rid of them are always welcome by those who have to bear the brunt of their attacks. Two species of *Anopheles* or malarial mosquitoes occur in this State, while numerous members of the genus *Culex* are also found. *Culex pipiens*, the common house mosquito, occurs practically everywhere. It is also quite possible that the yellow-fever mosquito, *Stegomyia fasciata*, is found in the extreme southern part of the State, but this need be no cause for alarm, except when yellow-fever outbreaks in the South become very prevalent, in which case there might be danger of infected individuals being brought north by boat or rail. It is improbable, however, that this would come to pass owing to the sanitary precautions that are being taken in the South to prevent the spread of this disease.



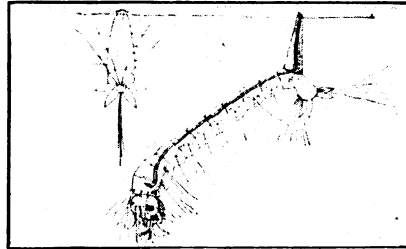
THE EGGS OF CULEX GREATLY ENLARGED.

Two eggs at left show shape of individual eggs. (After Howard, U. S. Dept. of Agr.)

EGG: The eggs of *Culex pipiens* and of *Anopheles* are laid in black floating masses, the number of eggs in the mass ranging from 300 to 400 in *Culex* and from 40 to 70 in *Anopheles*. These masses, unless carefully noticed, might be mistaken for specks of soot. The individual eggs are oval in shape and in *Culex* are fastened together side by side while in *Anopheles* they are fastened only at the ends and very often break apart. The eggs of *Culex* hatch in about twenty-four hours and those of *Anopheles* in from thirty-six to forty-eight hours.

LARVA: The larvæ with the pupæ are known as the wrigglers or wiggle-tails. The larva may be distinguished from the pupa by the size of the head end and by the presence of an air tube near the end of the abdomen, which is almost perpendicular to the body.

In *Culex* this air tube is very long while in *Anopheles* it is very short. The larvæ of the former species usually feed below the surface of the water, coming up occasionally for air, and at this time their body makes an angle of about 30 degrees with the surface of the water. Their color is dull blackish-brown. The larvæ of the

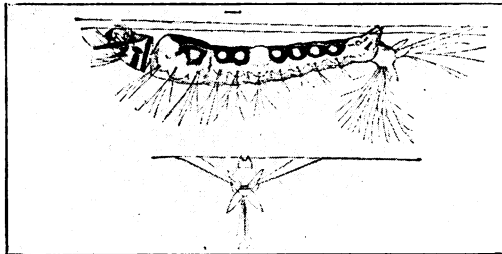


LARVA OF CULEX.

Showing position when at rest in water. Enlarged. (After Howard, U. S. Dept. of Agr.)

latter species usually feed very near the surface with the body parallel to it. The head is quite movable and can be rotated through an angle of 180 degrees. The body is blackish in color dotted and banded with white and yellow. The duration of this stage is from ten to sixteen days.

The larvæ feed on minute plants and animals that are present in the water in which they live. This stage of all of the mosquitoes



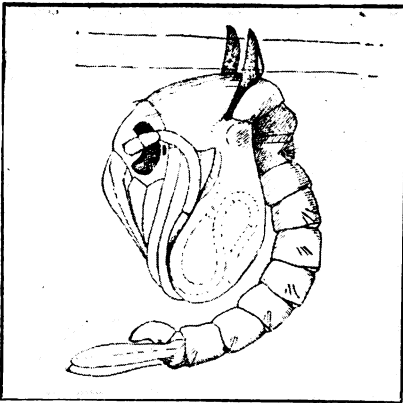
LARVA OF ANOPHELES. Enlarged.

(After Howard, U. S. Dept. of Agr.)

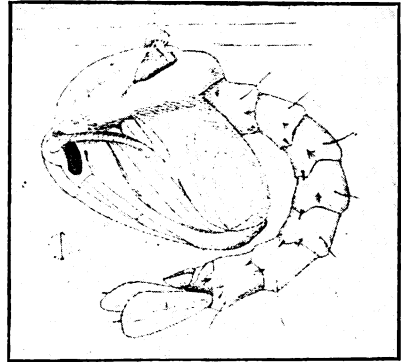
herein mentioned is usually found breeding in any container such as rain barrels, cisterns, or upturned cans and the like, that will hold water long enough for the completion of their life cycle.

PUPA: The pupæ lie at the surface of the water until disturbed and then become very agile and dart to the bottom. They do not feed and their appearance is very different from that of the larvæ,

the head end being very large or swollen, giving them a hump-backed or "comma-shaped" appearance. The pupa of *Anopheles* is very much more curved than that of *Culex*. The pupal stage lasts but three or four days.



PUPA OF *CULEX*. Enlarged.
(After Howard, U. S. Dept. of Agr.)



PUPA OF *ANOPHELES*. Enlarged.
(After Howard, U. S. Dept. of Agr.)

ADULT: All mosquitoes look very much alike, except to the close observer. The mouth parts of the female are distinctly fitted for piercing the skin and sucking the blood. Those of the male, as a rule, are degenerated and adapted only for taking nectar from flowers. In the case of the yellow-fever mosquito, however, the males as well as the females are said to bite.

COMMON HOUSE MOSQUITO.

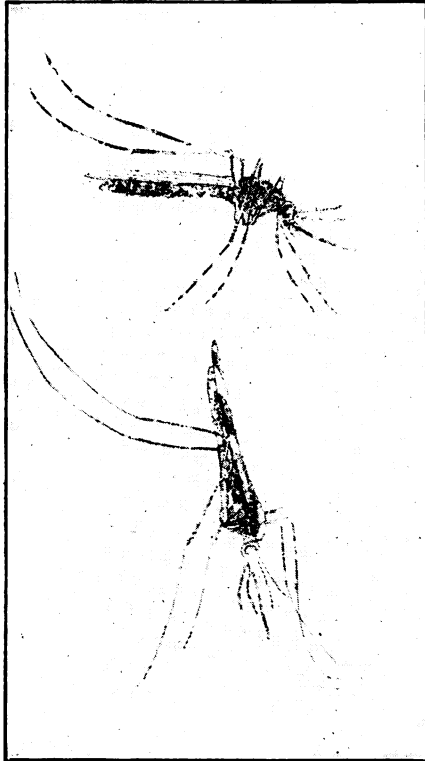
Culex pipiens—Linn.

This is a very annoying and persistent biter, of medium size and variable color with no noticeable characteristic markings. The head is brown, touched with yellow. The beak is brown, the thorax and abdomen are of the same color, the former tinged with gold and the latter with blackish. The abdomen is marked with narrow yellowish bands. This species is found in the house both day and night, though they cease biting if the room is very dark. They may be distinguished from the two *Anopheles* by the position of the body, which is parallel to the surface on which the insect is at rest.

MALARIAL MOSQUITO.

Anopheles maculipennis—Meig.

The legs in this species are very long. In size it resembles the preceding and is somewhat of the same color, but it assumes the attitude of standing on its head when at rest, a feature which distinguishes it from the members of the genus *Culex*. The veins



CULEX AND ANOPHELES.

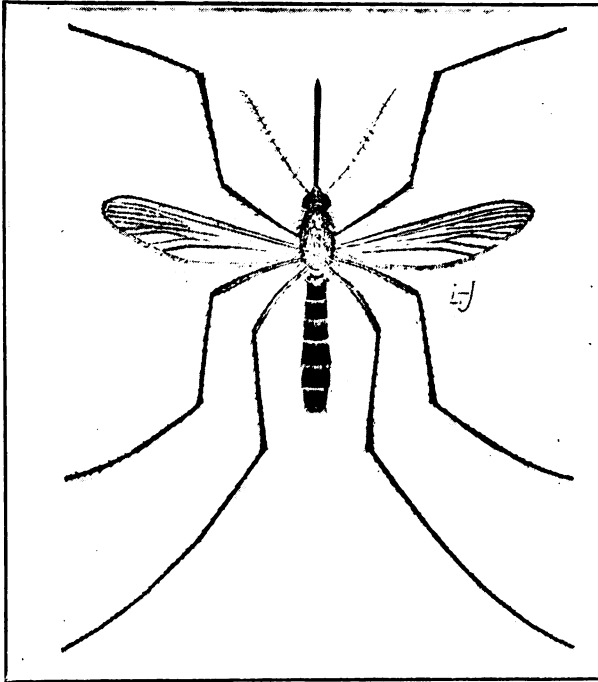
Showing their position when at rest. Upper figure, *Culex*; lower figure, *Anopheles*.
(After Howard, U. S. Dept. of Agr.)

of the wings are heavily covered with scales which are arranged in four distinct patches. This serves to distinguish this species from the preceding one. The malarial mosquito is not commonly seen by the layman because it is primarily a night flyer and usually leaves the house with the advent of day.

MOTTLED-WINGED MOSQUITO.

Anopheles punctipennis—Say.

In this species the legs, also, are very long and the habit of standing on its head when at rest is very noticeable. The general color is dark brown. The center of the thorax is gray and the abdomen is tinged with yellow. The legs and beak are not banded.



CULEX PAPIENS.

Adult female greatly enlarged. (After J. B. Smith, New Jersey Exp. Sta.)

The wings are heavily covered with blackish or yellowish scales and there are two heavy black patches on the front margin. Like the preceding species this, too, is a night flyer and very shy. There is still much doubt as to whether it is a carrier of malaria.

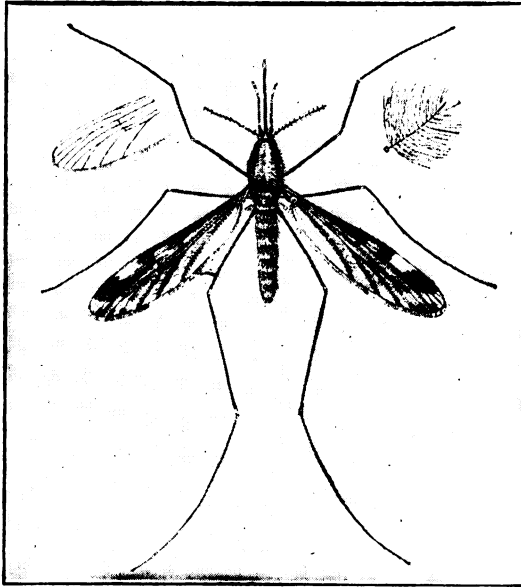
YELLOW-FEVER MOSQUITO.

Stegomyia fasciata—Fab.

This mosquito when slightly magnified is rather attractively marked with bands and dots which serve to distinguish it from any of the preceding species. Its general color is dark blackish-brown.

There are white dots behind each eye and at the base of the antennæ or feelers, and along the sides of the thorax. There is a white line on the thorax. The wings are unmarked. In size it is smaller than either species of *Anopheles* or *Culex*. In localities where it occurs, like the common house mosquito, it is also found in the house at all times of the day or night.

HIBERNATION: All of the species named hibernate in the adult stage. In *Anopheles*, however, only the females survive the winter.



MOTTLED-WINGED MOSQUITO (*Anopheles punctipennis*). Enlarged.

(After Howard, U. S. Dept. of Agr.)

REMEDIES: All the species mentioned are more or less weak flyers and as a rule do not travel more than 200 yards. Therefore, their breeding places are right at hand and may be either a swampy place, an open cistern, pails of water, rain barrels, shallow pools, sewers or even poorly made gutters or anything that will hold water for a week or more. Getting rid of these breeding places is the first essential in doing away with mosquitoes. If it is a swamp it may be covered with a thin coat of kerosene oil two or three times a season, or, better yet, it might be drained, if this is possible. Containers such as pails or cans should be gathered up

or treated with oil. The rain barrel or cistern should be securely sealed or covered with fine-meshed screen.

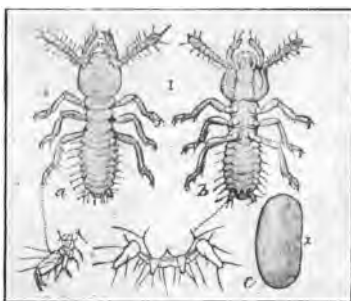
The screens of houses should be intact for the mosquitoes are very persistent in the search for food and will squeeze through any place that will admit their body. In ridding badly infested rooms of these insects pyrethrum may be burned as recommended for the typhoid fly.

For those who are forced to work in mosquito-infested localities, repellants may be used. Rubbing the exposed parts of the body with oil of citronella, which is diluted with an equal part of olive oil has been very effective when applied about every hour and a half.

WHITE ANTS.

Termes flavipes—Koll.

These insects are not ants, but instead are not far removed from the most primitive insects known, and are closely related to the book lice. The only resemblance that they bear to the true ants is a superficial one, namely, a similarity of social habits.



WHITE ANTS.

(a) Dorsal view of newly hatched nymph. (b) Same, ventral view. (c) Egg.
(After Marlatt, U. S. Dept. of Agr.)

These insects are noticed mostly in the spring, when like the ants their nuptial flight takes place. The forms then noticed, which will be described later, are not the destructive ones, but merely the colonizing individuals. Owing to the structure of these individuals it is possible that this nuptial flight is merely a remnant of a once useful habit and that the new colony is now formed merely by the division of the old one. The destructive forms are concealed from the light of day and are very delicate, shriveling up and dying if exposed to the air for any length of time. Conse-

quently their work is often unnoticed until the damage is beyond repair. This species of termite is a native insect and may be found burrowing in damp, rotting logs and often into young live trees in the woods. From the woods they have taken to the abode of man and may be found in damp houses tunneling the floors or underpinning, making such a structure a dangerous one in which



A SWARM OF WINGED TERMITES OR WHITE ANTS. (Original.)

to live. Often they bore into the furniture leaving a mere shell which collapses with the least weight. They may also be found among damp books or valuable papers where they may do a great deal of damage before their presence is even suspected. In the southern part of the State they have been found specially troublesome in nurseries where pecans are grown. Here their damage consists of tunneling through the newly planted stock.

New colonies are probably formed by the division of the old ones; the supplementary queen being developed from the nymph by special feeding. She retains throughout her life undeveloped wings, a feature which distinguishes her from the regular queen, who would have only wing stubs.

REMEDIES: Outbreaks in Indianapolis have shown that in the most part infestation is from an outside source, and it often happens where the underpinning of floors rests directly on the damp earth. Absolute dryness is one of the essentials in making a building safe from attacks. This, however, is often impossible, and in such cases the timber supports should be kept off the damp earth or only such timber used as has been saturated with creosote. Better still is the use of steel or concrete in such places. Where the insects are coming in from an outside source their nests should be located and destroyed. When the nest is found to be in the house fumigation with hydrocyanic acid gas or carbon bisulphide may be used according to the directions given in the chapter on "Insecticides." In libraries books should not be stored in damp places and should be examined frequently. In nurseries where pecan stock is being grown, we would recommend that such stock be grown as far from the woods as possible, and that all decaying timber in the vicinity of the nursery be gathered up and burned.

FLEAS.

Ctenocephalus canis—Curtis.

With the exception of the white ants, the fleas have attracted more attention in Indianapolis than any other insect that may be found in the home. During the first weeks of September the office received not less than 100 calls from residents in the northern part of the city asking for remedies against this vicious little pest. The writer, along with the chief of the department, had an interesting experience that will show the abundance of this pest in certain sections. At the first place visited we found the lawn literally alive with fleas which from this source were constantly being carried into the house. From the story told by the occupants the whole house was quite alive with fleas and they were especially bad in the bedrooms. We were interested in this particular case because the owners had never owned or harbored a stray cat or dog. They had been away the entire summer and could not understand why they should return home to find a host of hungry fleas to greet them.

We took up the matter and found that a large grass mat had been left on the front porch. From the neighbors it was learned that several cats had held nightly council on this mat, and the rest was easy. The crack underneath the door was large enough to admit fleas and once inside these found an ideal undisturbed abode, and since the weather of the past season was damp and rainy they reared a host of offspring in peace. The life history of the flea solved the mystery.

The second place visited was a double rental house where the whole place, from the basement to the attic, was literally black with this pest. The basement was very dark, somewhat dirty and rather damp; an ideal place for the development of the fleas. Even the grass around the house was swarming with the insects. The source of infestation here was a stray mother cat and a litter of kittens.

Fleas from more than two dozen places were mounted and examined and found to be the common dog and cat flea and not the house flea (*Pulex irritans*—Linn.).

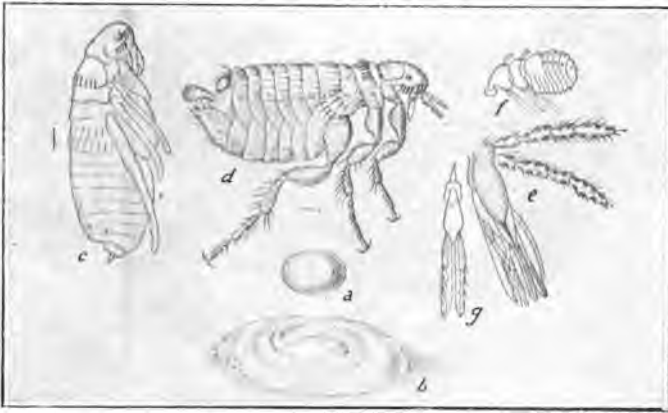
EGG: The eggs, unlike those of such parasitic insects, as the lice, are unattached to the host and are merely laid loosely in the hair of the animals. These eggs drop off readily, a fact which accounts for the infestation of houses where animals carrying fleas are allowed to run about. Where the fleas are found in the house in numbers they lay their eggs in the carpet, straw matting or in corners filled with dust. The eggs are whitish, oval and about 1/50 inch in length. The incubation period is about one to three days.

LARVA: The larvæ are small, white, footless grubs about $\frac{1}{8}$ to $\frac{3}{16}$ inch long, with brown heads and without eyes. The mouth parts are well developed for biting. The body is moderately covered with bristles—those toward the end being rather long and used when the larva moves about. Duration of this period is from ten days to two weeks. They live in dust, in grass, in carpets, in straw matting, or the bedding of an infested animal. Here they probably live on vegetable or other organic matter present, and it is readily seen that fleas do not need blood for their development and are very temporary parasites.

PUPA: The full grown larva spins a thin silken cocoon within which transformation takes place. The cocoon is brown, oval and attached by the bottom side and usually covered with dust and

dirt. It is about $\frac{1}{8}$ inch in length. The pupa is white, until just before emerging. The duration of this stage is about one week.

ADULT: The adult is about $\frac{1}{8}$ inch long and from blackish to brownish in color. The body is conspicuously compressed laterally with a minute and malformed head. The mouth parts are modified for sucking and biting. On the head and thorax are a set of heavy spines. The rest of the body is well supplied with bristles.



THE CAT AND DOG FLEA.

(a) Egg. (b) Larva. (c) Pupa. (d) Adult. (e and g) Mouth parts of adult. (f) Antenna. (b, c and d) Much enlarged. (a, e, f and g) More enlarged. (After Howard, U. S. Dept. of Agr.)

This insect is really a degenerate fly but is without wings and does not fly, as some people suppose. On the other hand, the hind legs are long and modified for jumping. The adults are found on cats and dogs and possibly on rats and mice. When they are numerous they do not hesitate to attack human beings. Fleas are very vicious biters and voracious feeders, and usually attack persons around the ankles, and rarely above the knees. Persons with a delicate skin often suffer severely from their bites, which swell up and look like large hives.

REMEDIES: Numerous remedies were tried by the writer. It was found that the use of naphthalene, as suggested by Dr. Henry Skinner, was a very good remedy, namely, copiously sprinkling naphthalene flakes around the floor of the rooms and closing them for about twenty-four hours. In seriously infested residences the following procedure proved most effective: The carpets and rugs were removed and then cleaned out with a vacuum cleaner to draw

out all the eggs and larvæ of the fleas. Next the floors were gone over with this vacuum cleaner to suck out all the dust in the cracks and corners. The floor was then washed with a hot soap suds solution containing about eight tablespoonsful of creolin to every gallon of suds. Gasolene was put in all of the cracks around the baseboards and the floor was again sprinkled with naphthalene flakes. In a day or so these were swept up and burned. The carpets, rugs, and straw matting were then put down and little further trouble was experienced. Putting flypaper, on which raw meat is placed, on the floor has proven ineffective. Flypaper may be put to better use by tying it, sticky side out, to the legs of a boy, and having him walk through infested rooms for several hours. In basements fumigation with carbon bisulphide was found to be very effective. Hydrocyanic acid gas was tried, but being rather lighter than air did not get into the crevices on the floor where the fleas were in hiding, and hence was ineffective. Burning sulphur did no good.

Where lawns were affected a thorough spraying of 10 per cent. kerosene emulsion was tried.

Dogs with fleas should be washed in a 2 to 3 per cent. solution of creolin, which may be made by putting two or three teaspoonsful of creolin in a quart of soap suds. Cats should be dusted with pyrethrum. This will stupify the fleas and cause them to fall off and they may then be gathered up and burned. All the bedding of domestic animals should be thoroughly cleaned every few days and the dust and dirt contained in them should be burned.

ANTS.

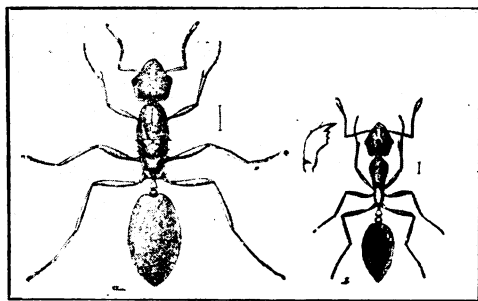
Two species of the ant have proved troublesome during the past season, the one being the red ant (*Monomorium pharaonis*—Linn.) the other the black ant (*Monomorium minutum*—Mayr.). Other species of the ant may from time to time prove troublesome, but as this is not a scientific treatise on all the species that may be found in the household we present merely a typical life history which will apply more or less to ants in general, but may vary, of course, depending on the species. The red ant usually builds its nest in buildings, either in the walls or in the flooring. The black ant is commonly found out of doors under stones or in the fields, where their presence may be told by the small dry piles of soil at the entrance of the nests.

Egg: The eggs of the ants are rarely seen, the commonly known egg being the pupa case. The true eggs are very small,

pale yellowish-white in color. The shape of the individual egg is longly elliptical. The eggs are laid in masses by the queen and are then taken to various parts of the nest and cared for by the workers.

LARVA: The larva is a delicate, blind, white, legless grub, resembling the fly maggot in general shape, but, unlike the maggot, having a very distinct head and well formed mouth parts. The body is composed of thirteen segments, three of which belong to the thorax and ten to the abdomen.

PUPA: The pupa cases are elliptical in shape and readily seen and as has been said are commonly mistaken for the eggs. These cases are made of rather tough silk and as a rule are of a yellow or pale brownish color. Within the case is a delicate white pupa which has a distinct head and legs and sometimes wing pads, depending upon the caste of the insects that emerge. In fact the pupa bears a very close resemblance to the adult to be.



THE COMMON RED HOUSE ANT.

(a) Female. (b) Worker. Both enlarged. (After Riley.)

ADULT: There are three classes of ants in the ordinary nest, the males, females or queens, and the workers. The winged males and females are produced during the summer and soon after emerging take their nuptial flight. The males, after the fertilization of the females, soon perish and the latter tear off their feebly attached wings and build up a new colony. Unlike the bees, several queens may be found living in harmony in the same nest. The workers, like the bees and unlike the termites, are all undeveloped females and never develop wings. They are about one-half the size of the males and females. They are the individuals which are commonly seen in the house, where they are attracted by the presence of food.

REMEDIES: The ants mentioned are not especially destructive to household effects, but the mere thought of their presence in the sugar or syrup or in other articles of food makes these articles unpalatable. The best remedy is to keep all food in well sealed containers so the ants cannot get to it. Keeping things absolutely clean is essential, for ants are attracted by the presence of grains of sugar or crumbs of bread on the floor. If these insects become numerous the only way to permanently get rid of them is to find the nest, by watching where the workers go, and then killing it out. The red house ant is usually hard to eradicate, but, if the nest is found, several ounces of carbon bisulphide can be injected into it, which will kill the queen and the workers present and the nest will then die out in time. The nest of the black ant may be located in the yard and may be treated by a like injection of carbon bisulphide, which may be applied through several holes in the top of the nest. These holes, after treatment, should be covered over with mud.

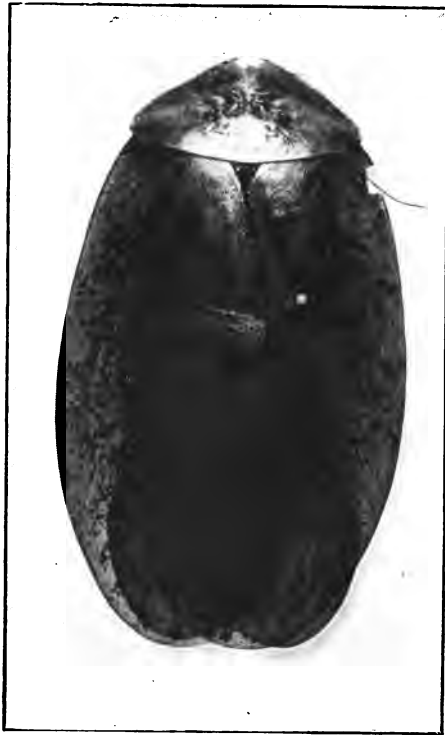
COCKROACHES.

Nothing is so disgusting to the cleanly housewife than to find these insects in the stored foods. Wherever they go they leave a nauseating "roachy odor," which comes partly from the excrement, but largely from the mouth and from scent glands. Seldom is it the fault of the housewife that cockroaches infest her premises, for they are noticed to have migratory habits more or less developed, which is especially true of the German roach or the Croton bug.

The cockroach belongs to the order Orthoptera, or straight winged insects, more commonly known as the grasshopper family. The stages passed through from the egg to the adult are practically like those of the grasshoppers. Though the cockroaches were at one time inhabitants of the woods, they early became associated with man, and several species have been carried to all parts of the world through commerce.

Three species of the roach are regularly found in Indiana, namely, the large American roach (*Periplaneta americana*—Linn.), which was a native of tropical and subtropical America, but has now spread to the ends of the earth; the German roach or Croton bug (*Ectobia germanica*—Scud.), that has been spread through commerce around the world; finally, the Oriental roach (*Blatta orientalis*—Linn.), a native of Asia, now found practically every-

where. All cockroaches shun the light and as a rule are fond of darkness and filth, hence they are thickest in the slum districts of the large cities and towns. Though they may do good because of their insectivorous and scavengivorous habits they are far more harmful because of their voracious appetites and because they leave an unclean trail behind them. The habits and life history of the three species are almost identical.



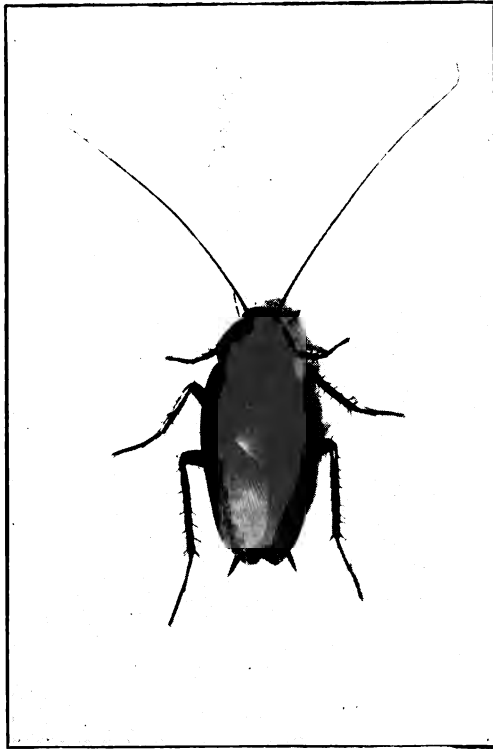
A LARGE SOUTH AMERICAN ROACH.

Sometimes shipped in with bananas. (After B. W. Douglass.)

Egg: The eggs are laid in hard horny cases called oötheca, which vary in size according to the number of eggs they contain. They are rather elongate in shape and round at both ends. They slightly resemble a bean. One of the longer edges is seamed and sealed with a sort of cement which the young dissolve by a liquid they secrete at the time of hatching. The Croton bug or German roach egg case contains 36 eggs in two rows and is of a light brown color, while the eggs of the Oriental roach contains only 16 eggs

in a single row. The egg cases are often carried around, partly extruded, by the female roach.

NYMPH: The nymphs resemble the adults in general shape, but are slightly lighter in color. The wing pads, of varying length, are present in the later instars. The duration of the nymphal stage varies with the species, the Croton bug taking about four to six months to reach maturity; the American roach taking about one year.

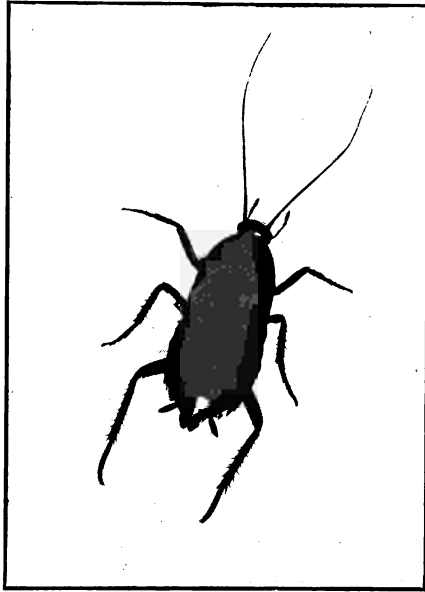


THE ADULT OF THE AMERICAN ROACH.

(First Annual Report.)

ADULT: The American roach is $1\frac{1}{3}$ inches long and rather reddish-brown in color with the edges of the pronotum (the shield-like structure just behind the head) bordered with yellow. This then leaves in the center of the pronotum a two-lobed dark brown spot. The wings and wing-covers reach beyond the end of the abdomen. The antennæ are about one and one-third times as long as

the body. The legs are well covered with stout spines. This is the least common of the cockroaches found in the house. It is rather more particular in its choice of abode than the other species



ADULT FEMALE OF THE ORIENTAL ROACH.

Enlarged about $1\frac{1}{4}$ times. (Original.)

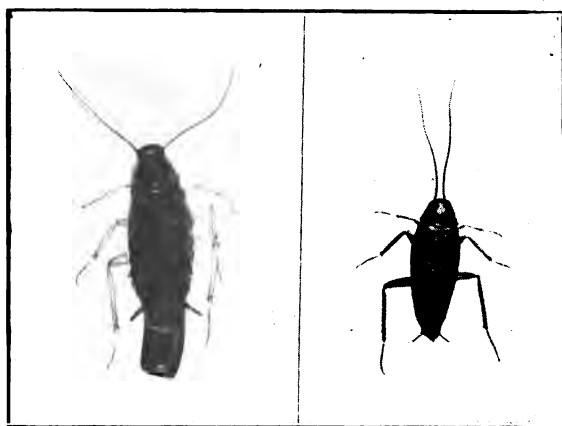


NYMPH OF CROTON BUG. (Original.)

and is found on the lower floors of the larger hotels in the city of Indianapolis, and also in the State Capitol. In the photographic darkroom of the Entomological Department they have done con-

siderable damage in eating off the coating of the photographic negatives.

The Oriental roach is about $\frac{3}{4}$ to $1\frac{1}{2}$ inches long, the female being larger than the male and broader in shape. The color is a dark blackish-brown with the legs somewhat lighter. The pronotum is not marked. In the female the wing-covers are very rudimentary and about $\frac{1}{5}$ of an inch long. In the male both the wings and wing-covers are well developed and cover about three-fourths of the body. This characteristic serves to distinguish this species from the preceding one. The antennæ are about three-fourths the length of the body. This is the filthiest of the house infesting roaches, and consequently is to be found in numbers in the large cities of the State and is seldom found in the thinly settled localities. It is carnivorous in its habits but is also exceedingly fond of stored foods. It is a particular enemy of the bedbug, but to introduce this roach to control bedbugs would be a very questionable policy.



THE CROTON BUG.

Adult female with oöthecum at left; adult male at right. Both enlarged, but in slightly different proportions. (Original.)

The Croton bug or German roach is the smallest and doubtless the most troublesome of the cockroaches. The length of the body varies from about $\frac{1}{2}$ to $\frac{3}{4}$ inch, the female being smaller than the male. The wing-covers of the male are about as long as the body, those of the female being slightly longer. The color of this

insect is a very light yellowish-brown with the legs often lighter. The pronotum bears two longitudinal dark brown stripes. The antennæ are slightly longer than the insect. The Croton bug is not as filthy as the Oriental roach and is consequently found in the better homes. Like all the house-infesting roaches, it is very fond of **starchy** foods.

REMEDIES: Fumigating infested houses with hydrocyanic acid gas is perhaps the best method of getting rid of roaches. Carbon bisulphide is also a very successful fumigant, in smaller rooms that can be very tightly closed. The methods of using these two fumigants is fully given in the chapter under "Insecticides." The use of proprietary roach poisons is of doubtful success unless the formula is known. There are sweetened pastes on the market which contain 1 or 2 per cent. of phosphorus, and these are very effective. Borax ground up with equal parts of sugar and chocolate and spread on moistened bread and placed where the roaches are abundant has been strongly recommended by the late Dr. J. B. Smith, State Entomologist of New Jersey. Mr. C. L. Marlatt of the Bureau of Entomology refers to a unique Australian method of killing roaches, which is as follows:

"Mix one part plaster of paris with three or four parts of flour in a saucer and place it where the roaches abound, with another plate nearby containing pure water, both supplied with several bridges to give easy access, and one or two thin boards floating on the water, touching the margin. The insects readily eat the mixture, become thirsty and drink, when the plaster sets and clogs the intestines. The insects disappear in a few weeks, the bodies no doubt being eaten by the surviving roaches."

Wherever possible a campaign to exterminate the roaches should begin early in the spring, when they come out of winter quarters, and before egg-laying commences.

CLOTHES MOTH.

Tinea pellionella—Linn.

Like the cockroaches, the clothes moth has been probably associated with man ever since he began living in dwellings. It is probably of European origin, but is now found practically over the whole world. As early as the middle of the 18th century it is recorded as being abundant in Philadelphia, a fact which shows its

early introduction into America. The work of the clothes moth is well known to every housewife, though it is sometimes confused with the work of the following pest, the carpet beetle or "buffalo moth." The clothes moth feeds on woolens of all sorts, on furs or even feathers, and does its most destructive work when these are stored for the summer and left undisturbed.

EGG: The eggs are very small and not readily seen by the naked eye. They are not more than $1/32$ inch long, longly ovate in shape, and glistening white in color. The eggs laid in captivity were deposited in rather irregular rows.



THE CLOTHES MOTH.
Showing adult and larvæ. (Original.)

LARVA: The larva is about $1/5$ inch long, whitish in color with the head and first segment brown. The larva lives in a sort of tubular nest made of bits of the material on which it is feeding held together by a lining of silk. Like the larva of the bagworm moth the clothes-moth larva carries this nest along with it and feeds with the head and thorax protruding from this protecting case. It is the larva that is really the destructive form of this insect and not the moth, as so many housewives suppose.

PUPA: The protective case of the larva becomes the pupa case and is attached by silk threads to the material on which the larva

worked. Within this case the larva transforms to a yellowish-brown pupa about $\frac{1}{5}$ inch long, which has no particularly striking characteristic. The pupal shell is usually found partly extruded from the case after the moth has emerged.

ADULT: The adult is a pale yellowish-brown moth with the wings uniform in color, the hind wings lighter than the front ones. Both pairs of wings are heavily fringed with delicate hairs. The wing expanse is about $\frac{1}{2}$ inch. This is not the destructive form, as many people suppose, but is the egg-laying form, and should be killed when it is seen. The moths abhor light and when disturbed fly aimlessly about in an attempt to conceal themselves. These moths are very short lived and die very soon after depositing their eggs.

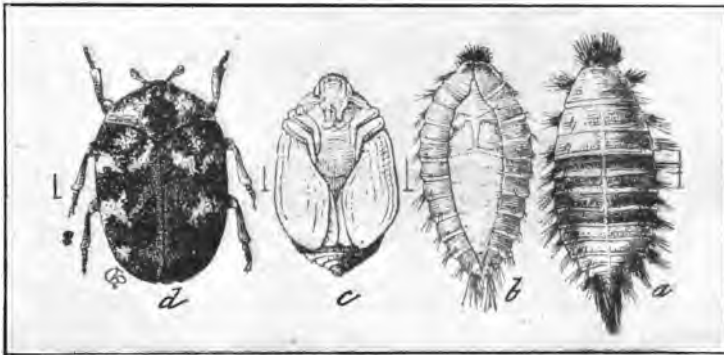
REMEDIES: Careful examination and a frequent and thorough brushing of the woolens that are stored for the summer is usually effective in the control of this insect as the brushing will keep the cloth free from the eggs and the work of any larvæ will be found before they have a chance to become very destructive. We, however, advise the following procedure for storing things for the summer: Thoroughly brush and fumigate all articles with carbon bisulphide in a small tight box lined with building paper, then brush again and put into large moth-proof paper bags, such as may be bought at drygoods stores. Large pasteboard boxes may be used if the edges are sealed. Carbon bisulphide has a rather disagreeable odor, but this will rapidly disappear if the articles are given a thorough airing when they are brought out in the fall.

For dealers in rugs, woolens or furs of any sort Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D. C., has shown that cold storage is the best protection against the clothes moth. The process described consists of alternating a rather low temperature with a high one, as follows: "First place the articles in a temperature of about 18 degrees Fahrenheit for a few days, which causes the larvæ to become dormant. When the articles are then moved to a temperature from 40 to 50 degrees Fahrenheit, the larvæ become active, and when the goods are again moved to a temperature of 18 degrees the larvæ die. After this such articles may be permanently placed at a temperature of 40 degrees." This method may be taken advantage of by persons in cities where there are large storage plants.

"BUFFALO MOTH."

Anthrenus scrophulariæ—Linn.

When this insect is called "Buffalo Bug" or "Moth" it is incorrectly named, for it is neither a true bug nor a moth, but a beetle, hence the name carpet beetle by which it is sometimes called is preferable to either of the others. Under this name, however, it might be confused with the black carpet beetle. The work of this insect is somewhat like that of the clothes moth, as it feeds on the same articles, though it is more abundant in carpets than in clothes. This insect is sometimes known as the museum beetle, but according to Dr. L. O. Howard, of the Department of Agriculture, Washington, D. C., while it is a museum pest in Europe, it has not as yet done much damage in American museums. In Indiana the common museum beetle is a very closely related beetle (*Anthrenus verbasci*). The life history of these two species is practically identical and the adults are very much alike.



THE "BUFFALO MOTH" OR CARPET BEETLE.

(a) Larva, dorsal view. (b) Pupa within larval skin. (c) Pupa removed, ventral view. (d) Adult beetle. All enlarged. (After Riley.)

EGG: The eggs are probably laid by the adult on the material on which the larvæ feed. It seems that the eggs have not yet been observed by entomologists, for no reference is made to them in literature.

LARVA: The larva is readily distinguished from that of the clothes moth, for it is a reddish-brown grub about $\frac{1}{4}$ inch long when full grown. Each segment of its body bears a tuft of rather long stiff hairs on each side. The anterior and posterior ends are

more hairy than the rest of the body. The larva is the injurious form of this insect, although the adults do some damage. The larvæ are rather resistant to unfavorable conditions and can go a considerable length of time without food.

PUPA: The pupa forms within the larval skin and this skin in time splits down the middle, revealing a whitish more or less ovate pupa within, which is about $\frac{1}{2}$ inch long. The duration of this pupal stage is very variable, ranging from several weeks to several months.

ADULT: The adult of this insect is an ovate blackish beetle, not quite $\frac{1}{2}$ inch long. The insect has a rather mottled appearance because of three irregular silvery-white transverse stripes on each wing-cover. There is also a longitudinal brick-red stripe down the middle of the back. The adults may often be caught on the windows in the spring after they emerge from the pupæ and have mated and laid eggs. They may also be found out-of-doors on flowers and the insect gets its name because in its native home, Europe, it was originally found on plants belonging to the Figwort Family (*Scrophulariaceæ*).

REMEDIES: The carpet beetle is a rather hard insect to control, especially if it becomes established. As yet, however, no cases of serious injury by this insect have been reported to the office. Doing away with carpets and substituting rugs and straw matting is one way to overcome this pest. Fumigating with carbon bisulphide or hydrocyanic acid gas, as is recommended in the chapter on "Insecticides," is perhaps the best method of control. Insect collections or collections of skins should be fumigated every two or three months and naphthalene flakes should be used freely as a repellant. It must be remembered, however, that naphthalene flakes are of little or no value in killing the "buffalo moths" when they become established.

BLACK CARPET BEETLE.

Attagenus piceus—Oliv.

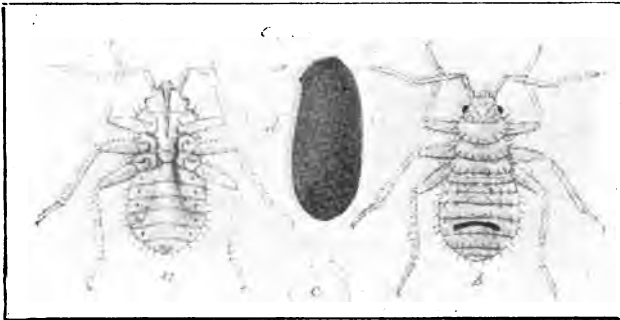
This species is found throughout the State, though it is more common in the southern counties. Its work is almost identical to that of the "Buffalo Moth," although it is on the whole a less injurious species.

The larva may be distinguished from that of the preceding by its general lighter brown color. The adult is oblong in shape, ranging from $\frac{1}{8}$ to $\frac{1}{5}$ inch in length. Its head and thorax are black in color and the wing covers are from reddish-brown to black. This insect is often found on windows in the house, and has been taken in numbers by W. S. Blatchley, former State Geologist, from the flowers of wild parsnip.

BEDBUG.

Cimex lectularius—Linn.

Like the clothes moth and the cockroaches, the bedbug, too, has early become associated with man and is mentioned in the writings of the ancients. At one time, however, it is possible that it was not a blood-sucking form, but more like some of its closest relatives which live on nectar, a fact that is substantiated, because even now when deprived of human blood bedbugs can live a long time on the moisture found in dust or old wood.



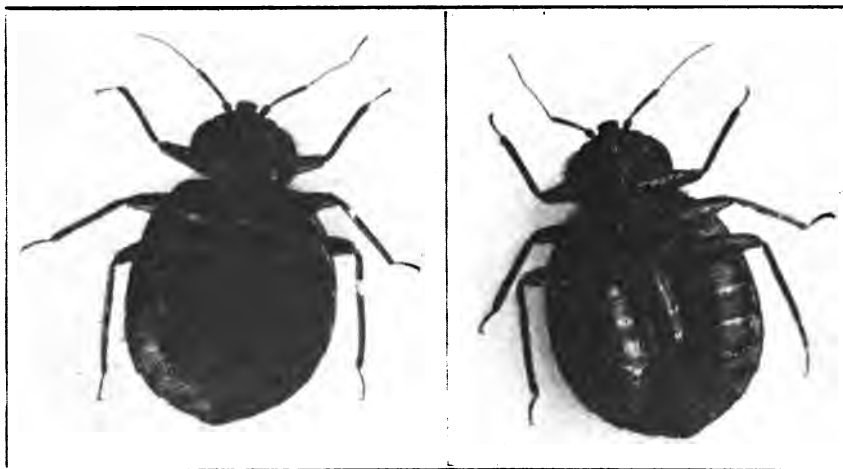
THE BEDBUG.

(a) Newly hatched nymph, ventral view. (b) Same, dorsal view. (c) Claw. (d) Egg. (e) Hair or spine from nymph. All greatly enlarged. (After Marlatt, U. S. Dept. of Agr.)

It is no disgrace for a housekeeper to have these pests slip in unawares, but it is certainly a disgrace for her to allow them to remain for any length of time. Bedbugs may often be carried by travelers either in their clothing or in their grips. They are indeed not infrequently found in street cars in large cities crawling over the seats. Then, too, these insects often migrate from one place to another, especially if the inhabitants of the infested house happen to move away. This is particularly true in the congested quarters of our cities and larger towns.

Egg: The egg is white in color, ovate in shape and about $1/16$ inch long. One end is distinctly rimmed and it is through this end that the larvæ escapes by pushing off the lid-like top. The eggs are laid in groups, the number in each group being very variable and reaching as high as 50. The eggs are laid in an out-of-the-way place, in crevices or cracks, a favorite place being the dust collected around the leather buttons of the mattresses. The incubation period is from eight to ten days.

NYMPH: The nymphs are from $1/16$ to $3/16$ inch in length, depending on the instar, and range in color from whitish, when first hatched, to brownish or blood-red. The nymphs resemble the adults in a large degree. The duration of the nymphal stage is about forty days.



THE BED BUG (upper and under side). Enlarged about 10 diameters. (Original.)

ADULTS: The adults are degenerate creatures and have lost their wings because they have had no further need for them in their long association with man. The adult bedbug is reddish-brown in color, oval in shape and slightly longer than $\frac{1}{4}$ inch. The legs and antennæ are rather light in color and if slightly magnified they are seen to be covered with strong hairs. The abdomen is covered with fine hairs, but on the whole it is of a rather sleek appearance.

The mouth parts are typical of those of the true bugs and formed for piercing and sucking. Both nymphs and adults give off a disgusting "buggy" odor through the scent glands. The bite

of this insect is rather poisonous to persons with a delicate skin, causing swelling and inflammation. Both nymphs and adults are rather gregarious in their habits.

REMEDIES: Bedbugs are rather hardy creatures, for the adults have been known to exist a year without food and newly hatched nymphs have been kept in a thrifty condition for three months without having tasted a meal. Thus, in combating them, remedies must be very thoroughly applied so that not a single individual will survive.

Druggists sell numerous remedies for bedbugs, most of which contain corrosive sublimate and wood alcohol, but these are rather ineffective unless very carefully and tediously applied. Where iron beds are used this insect is easily controlled, for the only hiding places are the mattresses and the wooden frames of the springs. If the mattress is brushed thoroughly and then fumigated several times with carbon bisulphide in a tight box all the bugs will be killed, especially if the infestation is only slight. When wooden beds are used the control of this insect is rather a hard task, for all the cracks and crevices must be flooded with gasoline, benzine, turpentine or kerosene at intervals of about one week.

Where the infestation is serious and it is evident that the bugs are not only hiding in the bed but also in the cracks and crevices in the room, fumigation with hydrocyanic acid gas is the most effective remedy. Burning sulphur as recommended by Dr. C. W. Stiles, of the U. S. Marine Hospital Service, 2 pounds for every 1,000 cubic feet of space was only partially successful in a series of experiments against these pests tried several years ago by the writer. Better success was obtained by carbon bisulphide fumigation, the directions for which are given in the chapter on "Insecticides."

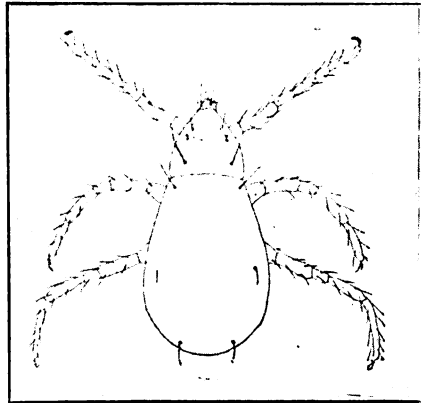
"CHIGGERS."

Genus Trombidium—et al.

Doubtless a large number of the people in Indiana have had experience with "chiggers" at some time or other. Many residents of the Hoosier capital who are wont to spend their summer vacations in the woods or in the country often form an intimate acquaintance with this annoying and "unseeable" pest. The "chigger" is not an insect, as is commonly thought, but, like the red spider, belongs to the mites which form a division of the spider

group, Arachnida. "Chiggers" are usually the larval stage of predaceous mites of the genus *Trombidium*, but other genera have attracted attention by causing injury rather similar to that caused by the "chiggers."

Several years ago considerable attention was given by the newspapers to a skin disease known as dermatitis, the cause of which was very obscure. It was especially prevalent among people working in wheat fields and those sleeping on mattresses filled with straw. Work undertaken by the Marine Hospital Service and the Bureau of Entomology connected this disease with the presence of a mite (*Pediculoides ventricosus*), which is parasitic on the wheat joint-worm. This of course accounted for the fact that persons sleeping on straw beds or working in the wheat fields should be particularly subject to the attacks of dermatitis.

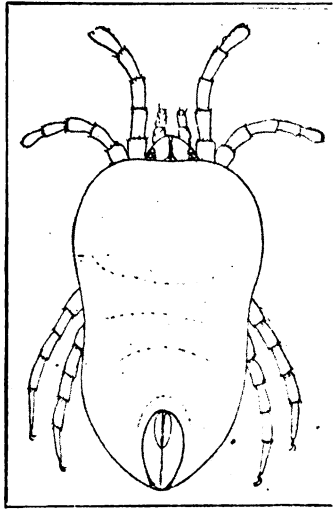


LARVA OF TROMBIDIUM Greatly enlarged. (After Banks.)

EGG: The eggs of the mites or "chiggers" are microscopic in size and brownish in color thus resembling, in a way, small one-celled fungi. They are laid in masses of often several hundred on the surface of the soil.

LARVA: These are the real "chiggers" and are microscopic in size. They are more or less red in color and oval in shape. These larvæ resemble those of the red spider to a large degree and have only six legs which, of course, distinguishes them from the adults. The larva of one species is a bright red in color and is found on house flies, mosquitoes, grasshoppers and other insects. The habit

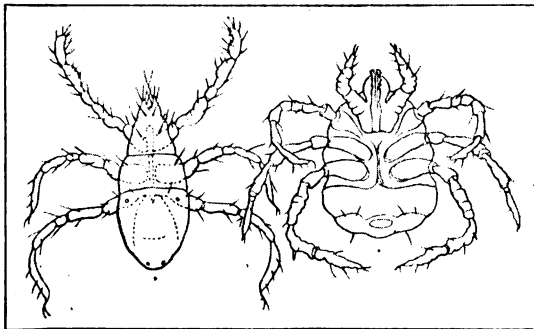
of burrowing into the skin of man is an abnormal one and as a result the mite dies within its burrow after it has become engorged with blood.



ADULT OF TROMBIDIUM Greatly enlarged. (After Banks.)

The "chigger" bite is too well known to need much description. It is usually a more or less circular inflamed spot $\frac{3}{4}$ inch in diameter resembling a large hive, or mosquito bite, in the middle of which there is a small water blister.

ADULT: The adults are quite visible and, like the larvæ, are various shades of red in color. The shape is more or less elliptical,



TWO PREDACEOUS MITES.

(*Leptus americanus* at left; *Leptus irritans* at right.) Highly magnified. (After Riley.)

but the abdomen is larger than in the larva and the head and thorax region is smaller. The adults have eight legs. In this stage these mites are predaceous on other insects, some attacking the aphids or plant lice, others the eggs of the scale insects, and still others feeding on small caterpillars and other insects.

REMEDIES: In the case of "chiggers" an ounce of prevention is worth several pounds of cure. Sulphur or naphthalene sifted into the underclothes, stockings and shoes will serve as a repellant. These may also be mixed with vaseline and rubbed into the skin. Another good repellant is a wash made of bichloride of mercury or corrosive sublimate, one part to 1,000 parts of water, and rubbed on the skin.

If the mites have gotten into the skin the only thing to do is to apply a counterirritant. Dr. L. O. Howard recommends an application of rather strong ammonia. Strong ammonia mixed with an equal part of chloroform has been found very effective by the writer.

If "chiggers" happen to infest the lawn, as is often the case about country clubs or around country residences, we would recommend keeping the grass cut short and applying sulphur and other sprays recommended for the control of the red spider on trees or in greenhouses.

LICE.

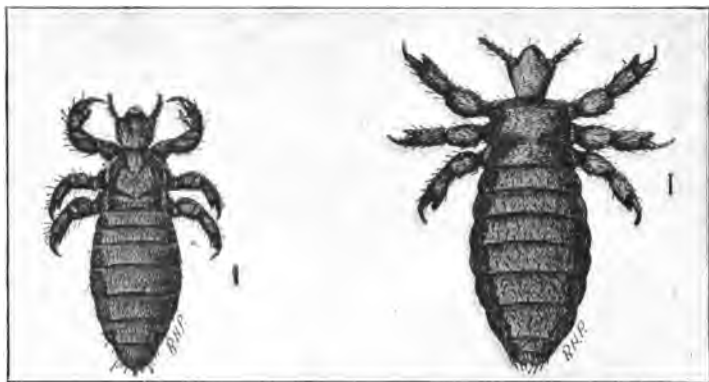
There are three species of lice affecting man; the Head Louse, *Pediculus capitis*—DeGeer; Body Louse, *Pediculus vestimenti*—Leach; Crab Louse, *Phthirus inguinalis*—Leach.

These disgusting insects are often found in slums or unclean quarters in our large cities, though it is not unusual to get them in the smaller and less clean hotels throughout the State when traveling. Occasionally they may be seen in the smoking cars and the day coaches of our railways, especially when numerous foreigners are traveling on them. School children in the poorer districts often get them through association with their playmates. Inquiry at the police station reveals that they are rather common on the numerous vagabonds slated on various charges.

Egg: The egg is about 1/40 inch in length, more or less whitish in color, and oval in shape. In the case of the crab louse they are attached to the hairs of the body by a mucilaginous substance which hardens after a short time. In the case of the head louse the eggs are attached to the hairs of the head, the largest numbers

being attached just behind the ears. The eggs of the body louse are laid in the clothing.

NYMPH: The nymph of the crab louse is readily distinguished from that of the other two species by its shape. The nymphs of the body and head louse are almost identical. In all species the nymphs resemble the adult in a large measure, though, of course, they are much smaller in size.



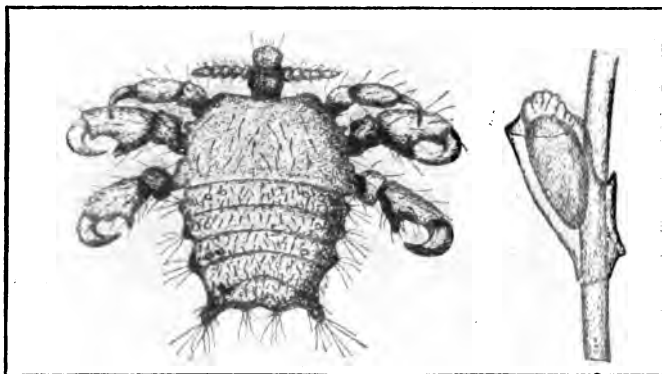
LICE.

Figure on left is the head louse of man; on right the body louse. (After Luggar, Minn. Exp. Sta.)

ADULT: The lice are bugs that have degenerated because of their parasitic habits. Because they spend their life cycle on or near the body of their host, they have little need of wings, and thus in consequence these have disappeared until today not even the rudiments are visible, and one would scarcely suspect the lice of being bugs, *Hemiptera*, were it not for the mouth parts. The mouth parts are more or less modified and are distinctly of the suctorial type. The legs in all species are modified for clinging, each bearing a more or less strongly recurved hook with which they can tenaciously cling to even a hair.

In the crab louse the body is almost as wide as long and the whole insect resembles a miniature crab, whence comes its name. The length is about 1/10 inch. It is of a more or less whitish color and has a distinct gray spot on each shoulder. The claws on the legs are strongly recurved and pale reddish in color. The crab louse is never found in the fine hairs of the head, though it frequently occurs in the eyebrows and beard and is particularly abundant around the pubic regions of the body and around the armpits.

The head louse is readily distinguished from the two preceding species because it is always confined to the head. It is more or less oval in shape and is longer than the crab louse, the length ranging from $\frac{1}{8}$ to $\frac{3}{16}$ inch. The color is whitish, marked with black on the sides of the thorax.



CRAB LOUSE AND EGG, BOTH GREATLY ENLARGED IN DIFFERENT PORTIONS. (After Luggar, Minn. Exp. Sta.)

The body louse is not readily distinguished from the head louse especially in the nymphal stage. In size and general shape the adults resemble those of the head louse, but the dorsal surfaces of the body are marked transversally with dark bands. The habits of the body louse may also serve to distinguish it from the preceding species, for it hides in the clothing and penetrates the skin of its host only when in want of food.

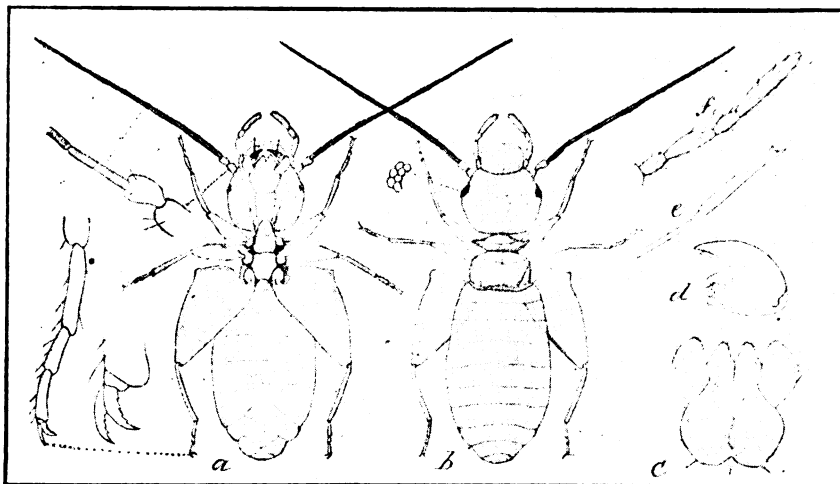
REMEDIES: Personal cleanliness is a prerequisite in combating lice. Sulphur and mercurial ointments should be applied to the body and should be effective in killing these pests. In the case of the body louse the clothing should be fumigated in a tight box with carbon bisulphide about three times at intervals of from two to four days.

BOOK-LICE.

Family *Psocidæ*.

The book-lice are not "lice" at all, but are far simpler insects and closely related to the white ants, as has been stated before. They are as a rule, of rather infrequent occurrence and unknown to many who claim to be close observers of insects. During the past season, however, which has been unusually moist, the presence

of these insects in large numbers has been called to the attention of the office. At one residence in the southern part of the city, numerous book lice were found in the excelsior upholstering of the leather covered chairs. Here it is probable that they were feeding upon the excelsior and not upon the leather, as no injury to the latter was noticed. At another place these insects were found in abundance in the books in the library and also behind the wall paper, especially around the moldings and baseboards where the edges of the paper had worked loose. Here the book-lice were evidently feeding on the paste.



A BOOK-LOUSE. (*Atropos divinatoria* Fab.)

(a) Adult from below. (b) Same from above. (c, d, e, f) Mouth parts. (After Howard and Marlatt, U. S. Dept. of Agr.)

Because they are, as a rule, of infrequent occurrence and because they are very small and not noticeable, the life history of the book-lice has been worked out only in a very general way. Specimens of the book-lice examined at the office show that there are several species that have been rather common this summer.

Egg: The eggs of the house-infesting species of this insect have not yet been observed. It is probable that they are laid in rather out-of-the-way places on or near the food stuff on which the nymphs and adults feed.

NYMPH: The nymphs resemble the adults, except in size and, as in the case of the white ants, the change from the nymphal stage to the adult is a very gradual one.

ADULT: The adult book-lice are very delicate, oval, whitish or pale yellowish insects about 1/25 inch in length. Those commonly found in houses are wingless and degenerate, but very near relatives living out of doors are winged and resemble plant lice to some extent. The mouth parts of the book-lice are made for biting and chewing tough substances and are practically like those of the white ants. The adults and nymphs are gregarious in their habits, but no castes are developed as in the termites.

REMEDIES: Since these insects are very minute and inhabit out-of-the-way places the most thorough methods must be used in getting rid of them. Sulphur fumigation has absolutely no effect on them. Hydrocyanic acid gas may be used, but it must be used somewhat stronger than is recommended in the directions under "Insecticides," and often then it will not kill all of these insects. Carbon bisulphide may be used in fumigating library books. The books should be placed in a tightly covered box and the carbon bisulphide poured on a cloth in abundance and placed with them and left at least twenty-four hours. As the book-lice occur in rather moist places a thorough drying out of such places will kill large numbers of these insects and often will effectively control them.

SILVER FISH OR "SILVER MOTH."

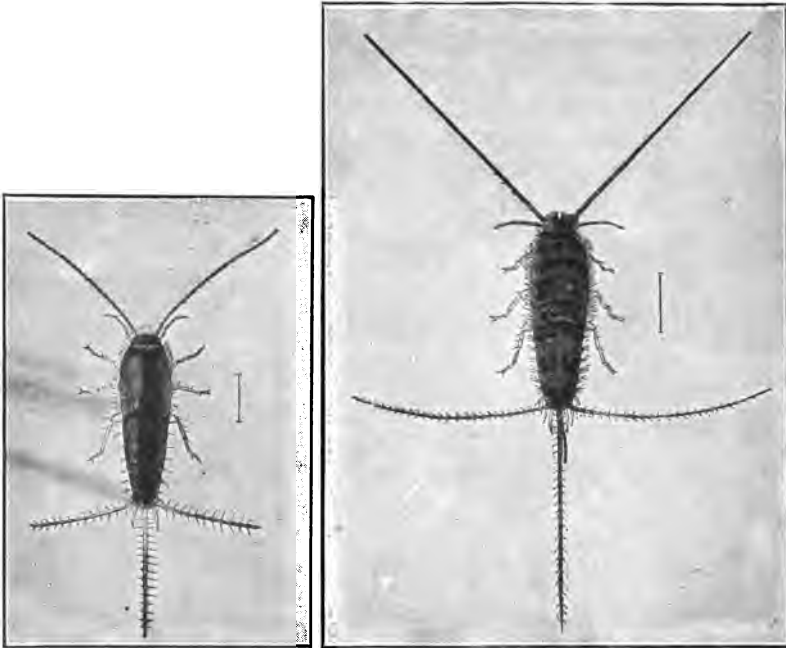
Lepisma saccharina—Pack.

Lepisma domestica—Linn.

Just why this insect should be called Silver Fish or "Silver Moth" is unknown except that perhaps the scales which cover the body rather resemble those of the fish. It is not a moth, nor even closely related to the moths, but perhaps the simplest of all insects existent today. In their habits, they are rather like the cockroaches and are fond of starchy foods. They are often seen scurrying about in pantries if a light is brought into the room suddenly, but it is nothing unusual to find them in the daytime in rather obscure corners. We have never found them to be particularly abundant or to cause any very serious trouble. The European *Lepisma* is found in bakeshops and seems to like the warm bricks of the bake ovens whence comes its name, "Fire Brat."

The life history of these insects seems to be rather incompletely worked out and this is especially true of the native American species (*Lepisma saccharina*).

Egg: The eggs are laid in dirt or dust or on hard substances, such as wood or stone, or in cracks or crevices. The egg is very variable in form, depending upon the substance on which it is laid. It is about one millimeter long and pale yellow in color. When the eggs are laid loose they are roundly oval in shape; when they are laid on wood they have the bottom half flattened so that they are half-ovoid in form, and when laid in cracks or crevices both sides are flattened where they touch the edges.



A SILVER FISH. (*Lepisma saccharina* Linn.)
(After Marlatt, U. S. Dept. of Agr.)

A SILVER FISH. (*Lepisma domestica* Pack.)
(After Marlatt, U. S. Dept. of Agr.)

NYMPH: The nymphs are practically identical with the adults, except in size, and there is scarcely any change except in size from the young to the mature insect.

ADULT: The adult is a silvery colored wingless insect about $\frac{1}{2}$ inch long, with a big head and a body which tapers gradually towards the tail. There are two long antennæ springing from the head. The mouth parts are made for biting and chewing. The segments of the thorax and abdomen are almost indistinguishable from each other. The legs spring from the thoracic segments and are quite

powerful and help the insect to run very rapidly. At the tip of the body are three long appendages, one which points directly backward and the other two which extend out a considerable angle. The body is well covered with minute scales, much like those of a moth. These scales are silvery and shiny and it is from these that the insect gets its name.

REMEDIES: The silver fish are very fond of moist situations and are seldom found in dry houses. Where they occur, however, they may be easily gotten rid of. If they are found in the library, eating off the glazed paper on the books or the starchy paste of the bindings, they may be killed by a thorough application of pyrethrum in such places. Where they hide in crevices, bits of cardboard covered with a poisoned starch paste may be inserted into these crevices and the insects killed when they eat this. This paste may be made by adding two ounces of white arsenic to a pound of starch paste.

A PRELIMINARY LIST OF THE PLANT-LICE OR APHIDIDAE OF INDIANA.

BY HAROLD MORRISON.

Plant-lice are the very common, small insects with long legs and feelers, which are found on roses, peas and many other plants. Their abundance during the past summer has made it necessary to give some information regarding them.

The following list includes only those species which have been found during the past summer by members of this office, or those species which have had records published showing that they have been found in the State. It is very incomplete, as there are a number of species of economic importance which have not yet been reported, but which must occur here, as they have been found in the neighboring States. Information as to the best methods of controlling these pests are given under each species of economic importance, and general control methods are given at the beginning of the list. Mr. J. J. Davis of the Bureau of Entomology, now at Lafayette, very kindly verified most of the identifications. Miss M. E. Siebenthal made all of the original drawings.

REMEDIES.

As all plant-lice are sucking insects, only those insecticides can be used for them which will kill when they touch the bodies of the lice. There are a number of these, anyone of which is usually satisfactory, but a few of them seem to produce better results than the others.

The commonest contact insecticide is kerosene emulsion. This should be made as follows: Dissolve one-half pound of hard, laundry or whale oil soap, or one quart of soft soap, in one gallon of boiling water. Remove from the fire and add two gallons of kerosene or coal oil. Agitate this mixture violently by forcing it through the spray pump and back into the vessel containing it, for five or ten minutes, until a white, creamy liquid is formed which has no drops of free oil on the surface. This is the stock solution, and must be diluted before using. For plant-lice on anything except very tender plants, it should be diluted at the rate of about one part

of the emulsion to nine or ten parts of water. For tender plants it should be diluted as much as one to fifteen. On some delicate plants it is better to use some other insecticide. The emulsion should be sprayed on with a nozzle giving a fine mist, and only enough should be used to wet all of the insects.

Another very good insecticide is whale oil soap. This may be purchased from certain dealers. It should be dissolved in water at the rate of 1 pound of soap to 6 gallons of water, and should be sprayed on as is the kerosene emulsion.

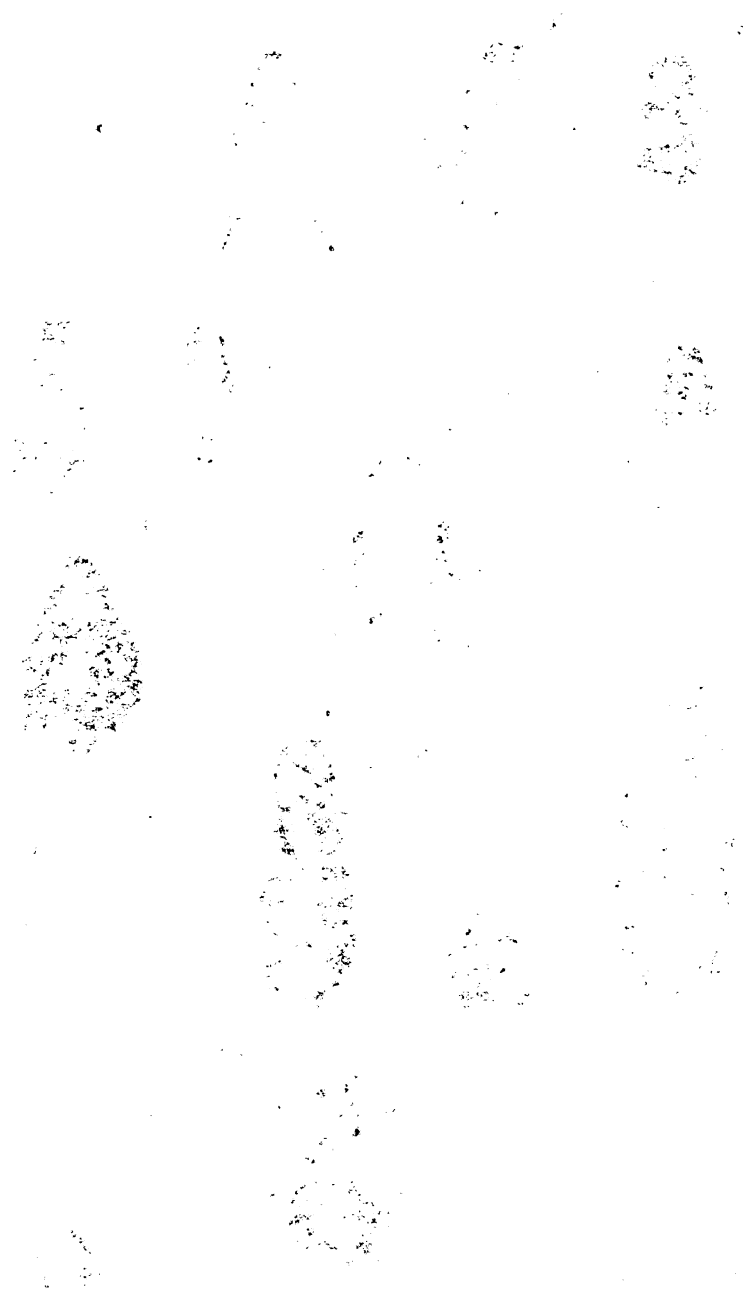
The lime-sulphur wash has been recommended for use in winter to kill the eggs of plant-lice on the apple and other trees. For this purpose, it should be used as for the San Jose scale at the rate of 1 part of commercial lime-sulphur solution to 8 to 10 parts of water. The results of this spray have not always been uniformly satisfactory, so it cannot be recommended with certainty.

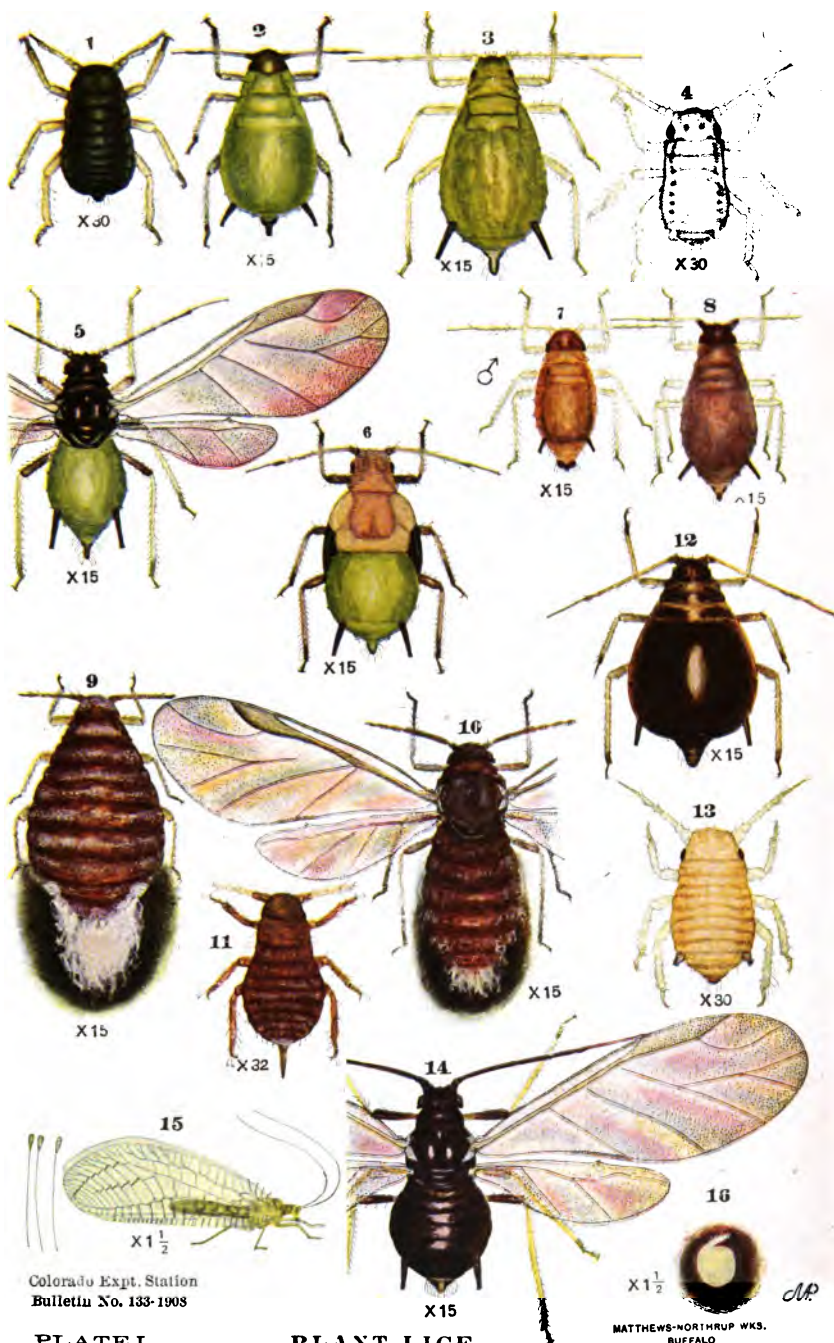
Perhaps the most efficient, and certainly the most satisfactory contact insecticide for plant-lice is one of the commercial tobacco solutions. These are made up to contain a definite amount of nicotine, and directions go with each package telling exactly how to dilute it. All that is necessary is to put the liquid into the proper amount of water, stir it thoroughly and spray onto the plants. One of the best of these is a nicotine sulphate solution known as "Black Leaf 40."

When good tobacco stems can be obtained, tobacco tea may be made by heating the stems in water at the rate of 1 pound of stems to from 2 to 4 gallons of water, so that the water simmers but does not boil. A spray solution made in this way should not be diluted, but should be put directly onto the plants.

Tobacco dust is frequently used in nurseries and around garden plants to repel some of the plant-lice which are found on the roots of many plants. A hole is dug around the plant, or a trench made alongside the nursery stock, and the tobacco dust is spread over the bottom, after which the earth is filled in again.

Carbon bisulphide, which comes in liquid form, is often used in controlling the Woolly Apple Aphis and some other root lice. A hole is made in three or four places around the base of the tree, and an ounce or so of carbon bisulphide is poured into each hole, after which it is quickly closed up again. This method is satisfactory only in porous soils, as the gas cannot penetrate a heavy soil. The carbon bisulphide is also used for fumigating for such insects as the Melon Aphis where the infested plants can be covered over.





Colorado Expt. Station
Bulletin No. 133-1903

MATTHEWS-NORTHROP WKS.
BUFFALO

PLATE I

PLANT LICE

EXPLANATION OF PLATES.

The Green Apple Aphis (*Aphis pomi* DeGeer).

- Fig. 1—Young Stem Mother.
Fig. 2—Adult Stem Mother.
Fig. 3—Adult Apterous Viviparous Female, Second Generation.
Fig. 4—Young Female, Second Generation.
Fig. 5—Winged Viviparous Female of Third Generation.
Fig. 6—Pupa of Preceding.
Figs. 7-8—Apterous Male and Female.

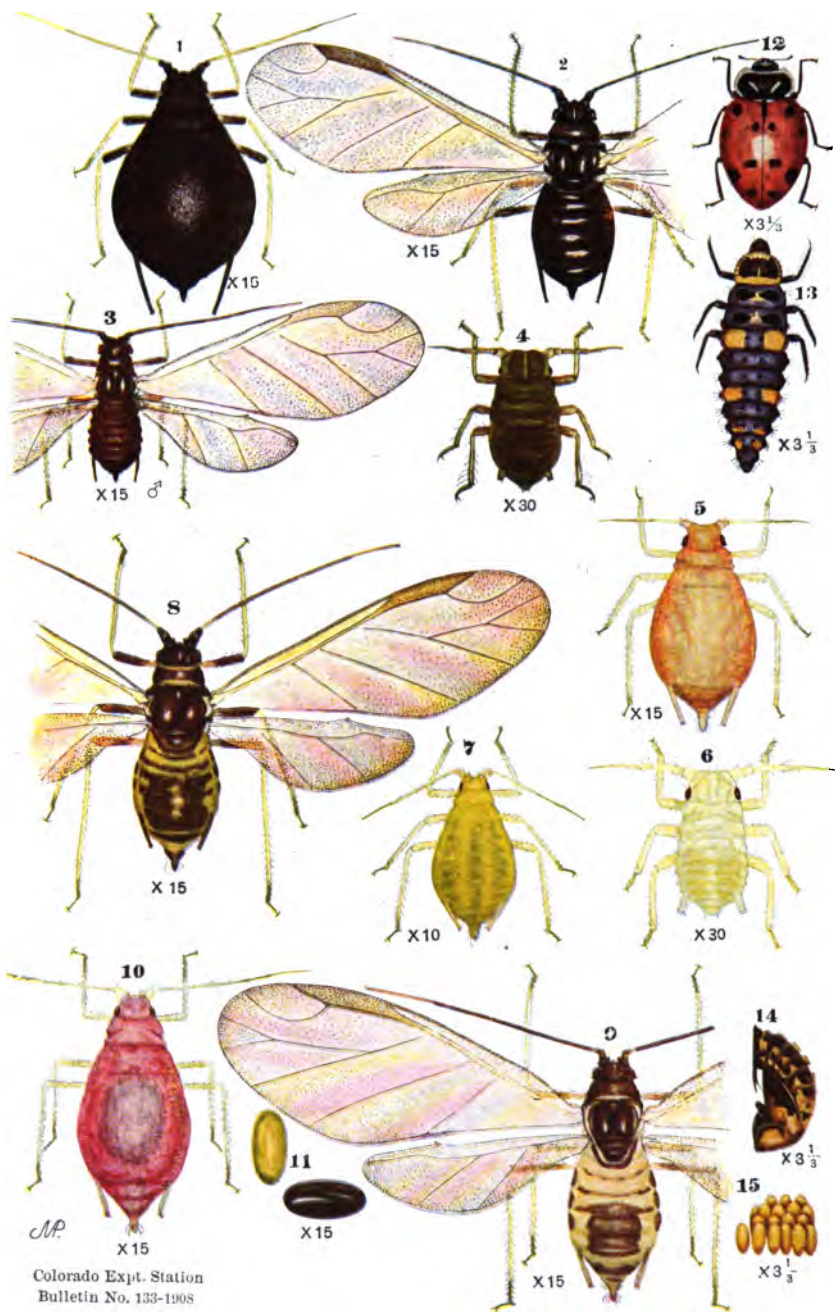
The Woolly Apple Aphis (*Schizoneura lanigera* Hausm.).

- Fig. 9—Apterous Viviparous Female.
Fig. 10—Fall Migrant.
Fig. 11—Over Winter Young.

The Black Peach Aphis (*Aphis persicae-niger* Sm.).

- Fig. 12—Adult Apterous Viviparous Female.
Fig. 13—Young Female, First Instar.
Fig. 14—Alate Female.
Fig. 15—*Chrysopa* sp. and Eggs.
Fig. 16—Cocoon of the Preceding.

(From Gillette & Taylor Bul. 133, Colo. Exp. Sta.)



Colorado Expt. Station
Bulletin No. 133-1908

PLATE 11

PLANT LICE

M. N. WORKS
BUFFALO

EXPLANATION OF PLATES.

The Black Cherry Aphid. (*Myzus cerasi* Fabr.)

Fig. 1—Apterous Viviparous Female.

Fig. 2—Winged Viviparous Female.

Fig. 3—Male.

The Green Peach Aphid. (*Myzus persicae* Sulz.)

Fig. 4—Young Stem Mother, First Instar.

Fig. 5—Adult Stem Mother.

Fig. 6—Young of Stem Mother.

Fig. 7—Apterous Viviparous Female of the Second Generation.

Fig. 8—Spring Migrant.

Fig. 9—Fall Migrant.

Fig. 10—Egg-laying Female.

Fig. 11—Eggs.

Figs. 12, 13, 14, 15—The Adult, Larvae, Pupa and Eggs of the Common Lady Beetle (*Hippodamia convergens*).

(From Gillette & Taylor, Bul. 133, Colo. Exp. Sta.

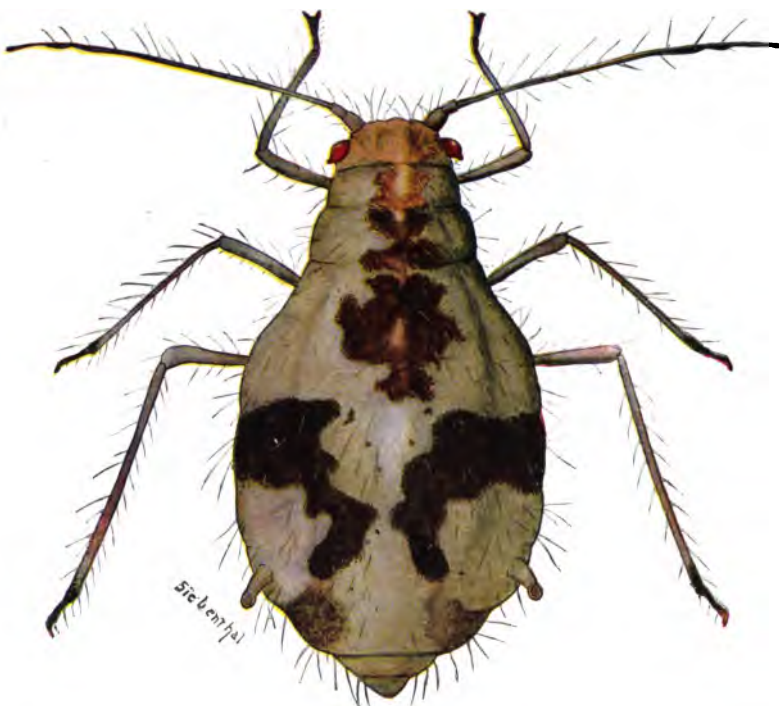


Fig. 1.

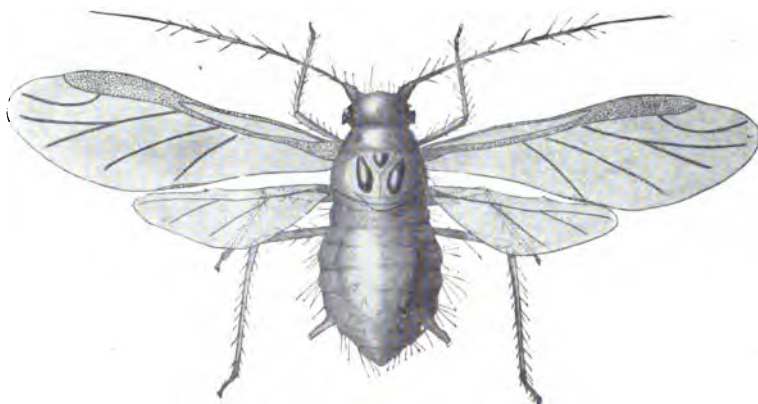
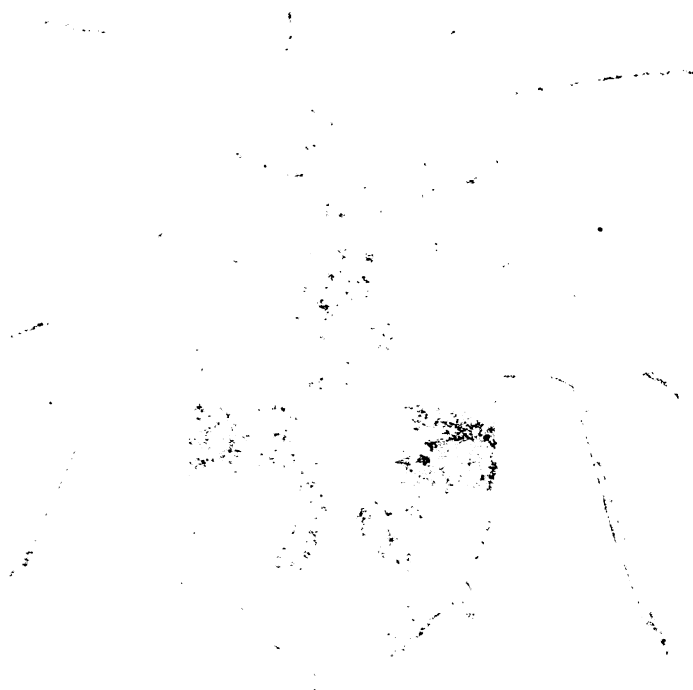


Fig. 2.

PLATE III.—The Maple Chaitophorus (*Chaitophorus aceris*, Linn.).

Fig. 1—Wingless Viviparous Female (Original.)

Fig. 2—Winged Viviparous Female. (Original.)



In greenhouses, what is known as tobacco paper is usually used to destroy plant-lice. Several kinds of this can be purchased and are fairly effective. Hydrocyanic acid gas is the most effective fumigating agent that can be used. It is dangerous, however, to make use of it in the greenhouse, as many plants are severely injured unless it is used very carefully. The proportion in which it is generally used in greenhouses is one ounce of potassium cyanide, two ounces of sulphuric acid and four ounces of water to 1,000 cubic feet of space. The fumigation should continue for about half an hour, but may last some time longer for hardy plants. The water should be put in an earthenware vessel, the sulphuric acid added to the water, and the potassium cyanide in a small paper bag should be dropped into the liquid. As this gas is a very deadly poison, the person doing the fumigating should be sure that he can get out of the house before the gas begins to generate. If the cyanide could be hung over the vessel by a string, and dropped into it from the door, it would be much safer. All openings in the greenhouse should be closed as tightly as possible before fumigation takes place, and the house should be aired out very thoroughly after fumigation is completed. All fumigation should be done at night.

For spraying such plants as roses and sweet peas in a home garden or city yard, a small hand atomizer or a bucket pump is sufficient. Where a greater amount of spraying has to be done, a barrel pump, geared sprayer, or even a power sprayer, is necessary. The latter is valuable because it gives sufficient pressure to force the spray material into many curled-up leaves which would otherwise be missed.

The few experiments in spraying for plant-lice that this office was able to observe showed that both the kerosene emulsion and the tobacco solutions were altogether successful. The form in which it comes makes the tobacco solution the easiest and best to use for a little work. It is more expensive in large quantities than the kerosene emulsion. It is also more satisfactory to use tobacco on very delicate plants, as it was found that nasturtiums, which were badly attacked by two different kinds of plant-lice, recovered completely after being sprayed by Black Leaf 40, while most of the leaves were wilted when kerosene emulsion, diluted at the rate of one to fifteen, was used. Black Leaf 40 was also used with excellent results in spraying for the Maple Chaitophorus and the Tulip-tree Louse, both of which were very common during most of last June.

NATURAL ENEMIES OF PLANT-LICE.

Among the most important of the natural enemies of plant-lice are the ladybird beetles. These are rather small, half-spherical insects, belonging to the family Coccinellidæ. There are a number of different kinds, almost all of which are beneficial. The most common lady beetle feeding on plant-lice is the Nine-Spotted Ladybird (*Coccinella novemnotata*). It is about one-fourth of an inch long, with black head and body, and with the wing covers orange-yellow, marked with nine black spots. This insect is most beneficial in the larval stage. This species became very common about the first of July on the maples and other trees badly infested with plant-lice in Indianapolis. Another very common aphid feeder is the Two-spotted Ladybird (*Adalia bipunctata*). It is smaller than the preceding species, and has only two black spots on the wing covers, one on each. Another kind which frequently attacks the Melon Aphis and other species of plant-lice is the Convergent Ladybird (*Hippodamia convergens*). (Pl. II, Figs. 12-15.) This form has thirteen black dots on the orange wing covers. The Spotted Ladybird (*Megilla maculata*) is often very helpful in destroying plant-lice on corn. This form is more elongate than any of the preceding and is dark pink in color, with ten black spots on the wing covers. It is frequently found in the winter under loose bark of dead trees and in similar situations, where it hibernates. There are a number of other species in addition to the above which also feed on plant-lice.

Besides the lady beetles, the Syrphus-flies destroy large numbers of plant-lice. While the lady beetles are predaceous both as larvæ and as adults, only the larvæ of the Syrphus-flies feed on plant-lice. The adults are extremely common around the summer flowers, and were to be found by thousands during the past summer. The eggs may be frequently noticed beside a cluster of plant-lice. They are long, round at both ends, and white. The larvæ which hatch from them are most often light green in color, and when full grown somewhere near one-half an inch long. The head is very small, and the body tapers from the back end towards the head.

As both the lady beetles and the Syrphus-flies pupate on the plants, usually in the midst of the plant-lice, care should be taken not to destroy any more of them than is necessary. The pupæ of the lady beetles are usually black or dark colored, almost oval, with the end by which it is attached a little pointed, and hang down from a pad attached to the bark. They have a characteristic habit

of flipping the whole body when disturbed. The pupæ of the Syrphus-flies are brown, elongate-oval bodies, with more or less distinct rings around them, and are to be found attached to the leaves on which the plant-lice are feeding.

Besides the predaceous insects which have been mentioned above, there are many parasitic insects which attack plant-lice. These are usually very small and are frequently missed. The effects of their work on the plant-lice may be easily seen, however. Usually the parasitized louse swells up and loses its natural color. Soon the skin dries and hardens so that the body of the aphid serves as a protection for the parasite until it is ready to hatch out. Plant-lice with a round hole in them from which the parasite has emerged are very common in large colonies. None of the lice which are known to be parasitized should be destroyed unless it is necessary, as the parasites will hatch out and fly to other plants to infest the colonies of lice on them.

A List of the Indiana Aphididae.

Trama erigeronensis Thomas.

This is a dull yellowish or whitish louse, with six rows of round, white, waxy spots on the back and sides, and with the white, waxy substance scattered over the body. Only the wingless form has been found.

It was plentiful in June on the roots of the common white-top (*Erigeron canadense*), especially in moist places around Indianapolis. In addition, it has been reported on a number of different grasses. At present it is of no economic importance.

Phylloxera caryaecaulis Fitch.

This species, found on several kinds of hickory, is most easily recognized by the gall it makes on the leaf petioles and young twigs. This gall is globular or oval, and from one-fifth of an inch to one inch in diameter. When they occur in numbers, they usually grow together. The gall may be smooth or spiny, depending on the tree on which it is formed.

This insect was found in the northern part of the State on *Hicoria glabra*, on which it formed a smooth gall. The winged females were full grown about the middle of June.

Phylloxera caryae-fallax Riley.

This species forms a gall on the leaves of *Hicoria alba*, varying from one-twenty-fifth to one-fifth of an inch in diameter. The color of the gall is greenish-yellow when young, and becomes brown when old. It was reported from Indiana by M. T. Cook in his List of the Insect Galls of Indiana.

Phylloxera caryae-globuli Walsh.

The gall of this insect is pale whitish-green in color, frequently tinged with red and about one-fourth to one-half an inch in diameter. It is formed on the upper side of the leaf of the shellbark hickory (*Hicoria alba*). Reported by Cook in his List of the Insect Galls of Indiana.

Phylloxera caryaevenae Fitch.

The gall of this species is an elongate fold on the under side of the leaf along the veins, and has a corresponding ridge on the upper side of the leaf. This is also reported by Cook. It is found on *Hicoria tomentosa* and some other species.

Phylloxera depressa Shimer.

The galls are found on *Hicoria alba*. They are smooth, round above and pale yellowish green. It is a very flat gall which projects equally above and below the leaf. It varies from about one-sixth to one-fourth of an inch in diameter. This is another species reported by Cook.

Phylloxera viticola Fitch.

The Grape Phylloxera.

The galls of this species on the leaves of the wild grape were very common in several parts of the State, so it occurs over the whole State without much question. These galls are green in color and spherical, but very irregular. They are sometimes so common as to almost completely cover the whole surface of the leaf. On the roots a small swelling is formed, which in nonresistant vines soon rots, destroying all of the root below it. It is not to be considered a serious pest in Indiana so far as our reports go.

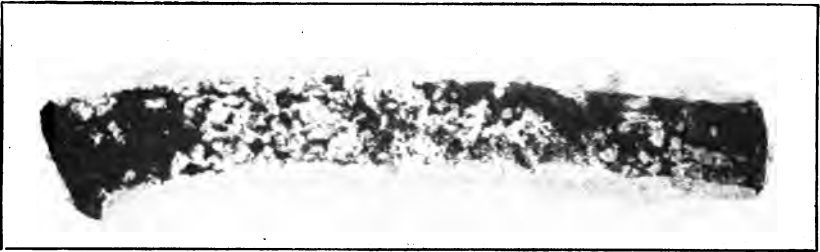


LEAF GALLS OF THE GRAPE PHYLLOXERA ON WILD GRAPE. (Third Annual Report.)

Chermes pinicorticis Fitch.

This insect attacks pine trees, and it may be readily recognized when present by the white woolly substance covering the bark of the trees. The trees are seldom killed by attacks of this louse, as several natural enemies help to hold it in check. It was reported only once in Indiana, on white pine near Indianapolis. In other States it has been found on Scotch and Austrian pines as well as on white pine.

The best time to spray for this insect would be in early spring just before the hibernating season is ended, using some standard spray.



Chermes pinicorticis Fitch. ON BARK OF WHITE PINE.

(From Bul. 173, Maine Experiment Station.)

Cerataphis lataniae Boisduval.

This is a very peculiar aphid which is found on palms in greenhouses in temperate countries, and out of doors in the tropics. So far as is known, this is the first published record for this country. The insect is very flat, oval, and has a fringe of white, waxy filaments around the whole edge, which are united. The body is divided by a cross line a little before the middle. It occurs on the upper surface of the palm leaves, and resembles a white-fly to some extent. There were no winged forms, although these are sometimes developed. It was found in two Indianapolis greenhouses, but it was not very common.

Hamamelistes spinosus Shimer.

By deforming a fruit bud, this species makes a gall on witch-hazel which is oblong, green, and covered with long spines. It was reported from Indiana by Cook.

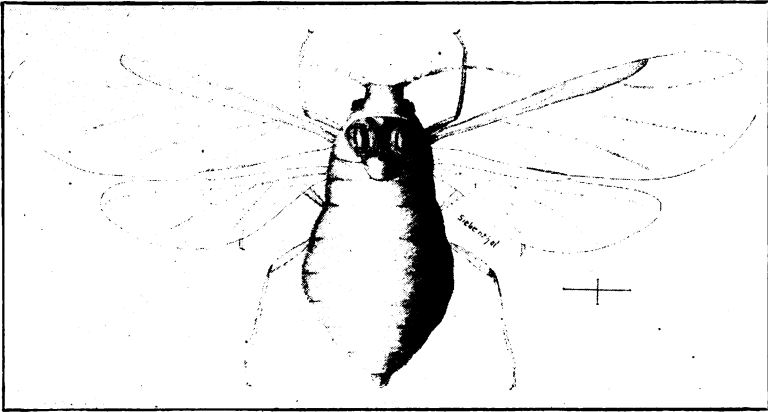
Hormaphis hamamelidis Fitch.

A green, conical gall is produced on the upper sides of the leaves of witchhazel by this insect. It was also reported by M. T. Cook.

Pemphigus fraxinifolii Riley.

The Ash Pemphigus.

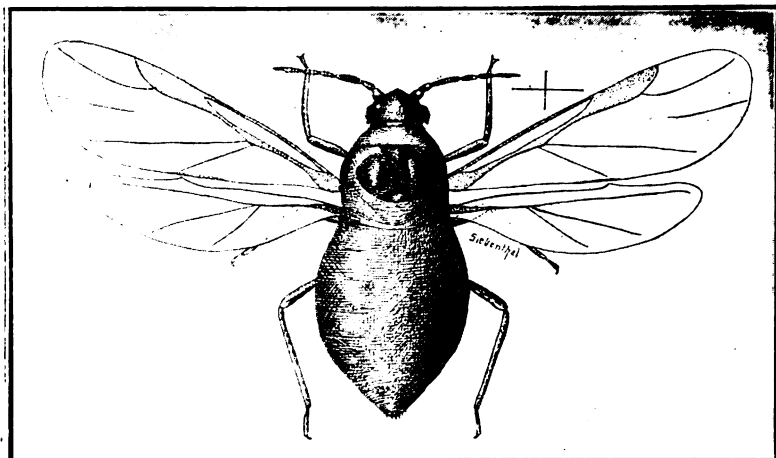
This insect proved to be very common on the American ash (*Fraxinus americana*) throughout most of June, and while it disappeared later, the evidences of its work remained during the summer. It attacks the leaves of young shoots and twigs, and curls them up, sometimes quite tightly. The lice secrete much flocculent wax, and this and the drops of honey-dew are very common inside of the curled leaves. The winged females develop in June.



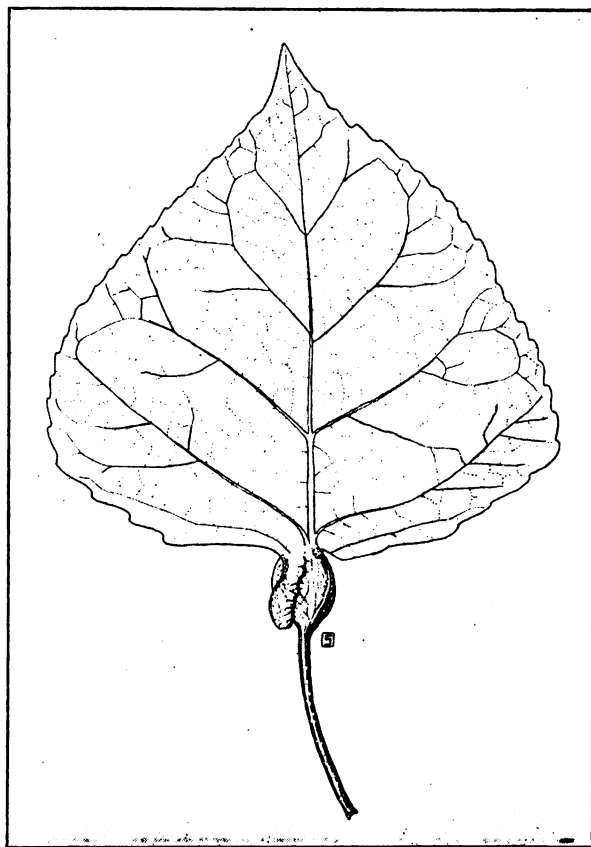
WINGED VIVIPAROUS FEMALE, *Pemphigus fraxinifolii* Riley. (Original.)



WINGLESS VIVIPAROUS FEMALE, *Pemphigus fraxinifolii* Riley. (Original.)

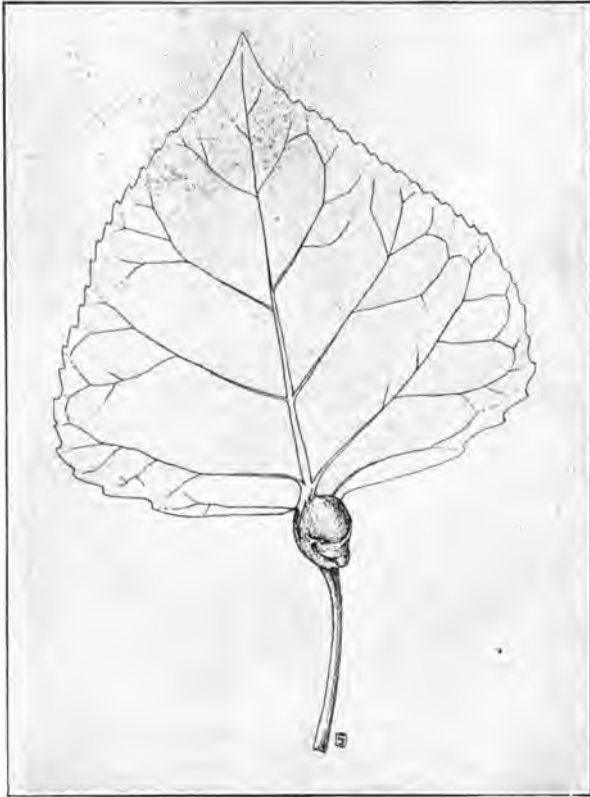


WINGED VIVIPAROUS FEMALE, *Pemphigus populicaulis* Fitch. (Original.)



GALL OF *Pemphigus populicaulis* FROM BELOW. (Original.)

To control this insect effectively, it will be necessary to spray the infested parts as soon as it is noticed, since the curling of the leaves makes it almost impossible to reach all of the lice.



GALL OF *Pemphigus populicaulis* FROM ABOVE. (Original.)

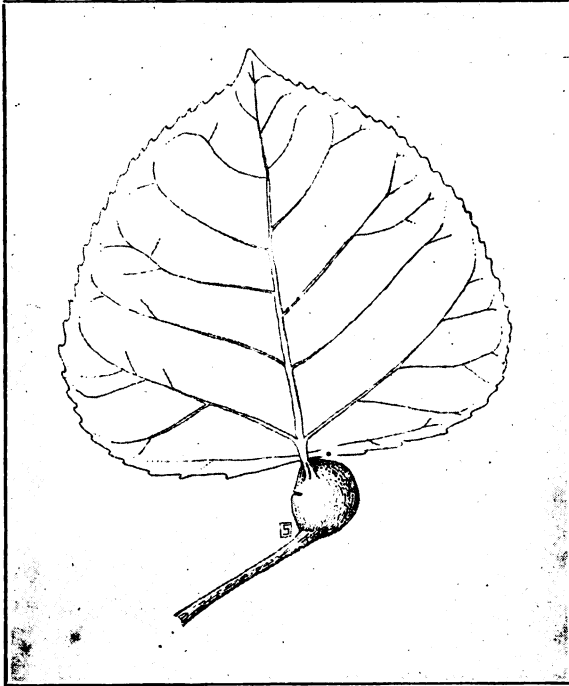
Pemphigus imbricator Fitch.

This insect clusters on the under side of beech limbs, and covers itself with a woolly mass much as does the Woolly Apple Aphid. The insect itself is black. It was reported as occurring at Goshen in the northern part of the State.

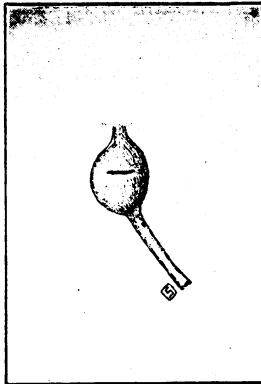
Pemphigus populicaulis Fitch.

The gall of this insect is the easiest thing by which to identify it. This is formed on the leaf petiole at the base of the leaf, is globular in shape, and has a long narrow opening running parallel

to the petiole and wrinkled along the edges. When first found near Indianapolis on June 25th, the galls were almost full grown

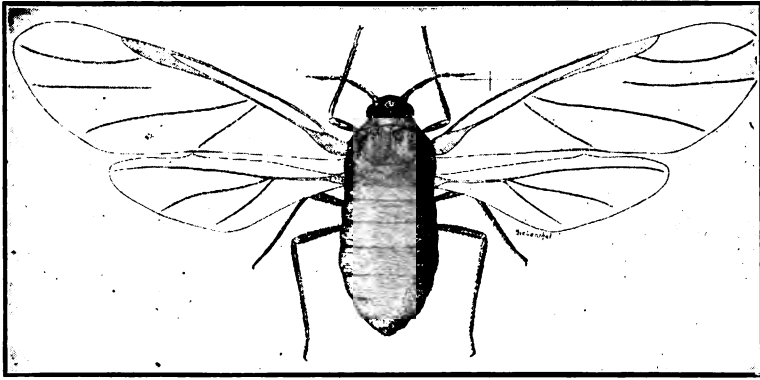


GALL OF *Pemphigus populi-transversus* Riley, FROM ABOVE. (Original.)



GALL OF *Pemphigus populi-transversus* Riley.
Showing the slit-like opening. (Original)

and contained nearly mature nymphs. About two weeks later only a few winged forms could be found in the galls.



WINGED VIVIPAROUS FEMALE, *Pemphigus vagabundus* Walsh. (Original.)



GALL OF *Pemphigus vagabundus* Walsh. (Original.)

Pemphigus populi-transversus Riley.

The gall of this species is formed on the petiole near the leaf base. It is elongate-oval in shape, with the petiole running along one side, and the opening, a cross slit, on the opposite side from it. The galls had only young nymphs in them when found near Indianapolis on July 8th, the time when the galls of *P. populicaulis* were fully mature and most of the inhabitants gone. The winged forms developed some time later.

Pemphigus vagabundus Walsh.

The Vagabond Gall-louse.

Here again the gall is quite characteristic of the species. It is green, very irregular in outline, branched, and when mature has an opening at the end of each branch. The gall is formed on the end of a young twig. The gall shrivels and turns brown soon after the insects leave. It was about mature on the 25th of June, near Indianapolis, but specimens collected three weeks later in the northern part of the State were still closed and had nothing but nymphs in them. It was found on sprouts of the Carolina poplar at Indianapolis, and on both Carolina poplar (*Populus deltoides*) and quaking aspen (*Populus tremuloides*) near Lake Wawasee. The quaking aspens were badly injured, and in some cases were almost killed by the numerous galls.

Pemphigus ulmifusus Walsh.

The Red-Elm Gall-louse.

This louse makes an elongate gall, pointed at both ends, and about one inch high, on the upper side of the leaves of the red or slippery elm. These galls were found near Indianapolis and at Oaklandon, but never in numbers. The galls mature about the end of June or the first of July, when the winged forms may be found.

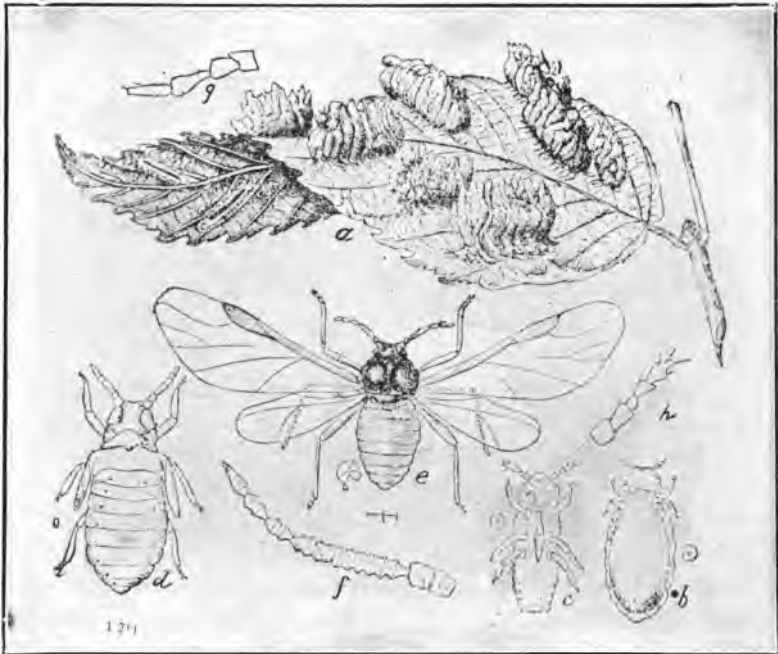
Colopha ulmicola Fitch.

The Cockscomb Gall-louse.

This insect is the one that forms the very numerous cockscomb galls on the elms. It was found commonly in all parts of the State. The galls reach maturity in June, and the winged forms which



GALL OF THE RED-ELM GALL LOUSE.

Pemphigus ulmifusus Walsh. (From Bul. 181, Maine Exp. Sta.)THE COCKSCORN GALL-LOUSE, *Colopha ulmicola* Fitch.

(a) Galls on leaf. (b) Impregnated egg surrounded by skin of female. (c) Newly hatched young.
 (d) Pupa of second generation. (e) Winged female. (f) (After Riley.)

come from them fly to grasses of different kinds to spend the rest of the summer. In the fall the winged females again migrate back to the elms, and produce a sexual generation, the females of which lay their eggs in a protected place on the bark.

Schizoneura americana Riley.

The Woolly Elm-Leaf Louse.

This was a very common species around Indianapolis, and is without doubt distributed through the whole State. It forms colonies on the under sides of the leaves of the American elm, and causes them to curl badly, injuring the appearance of the foliage. These galls were most noticeable during June.

Schizoneura crataegi Oestl.

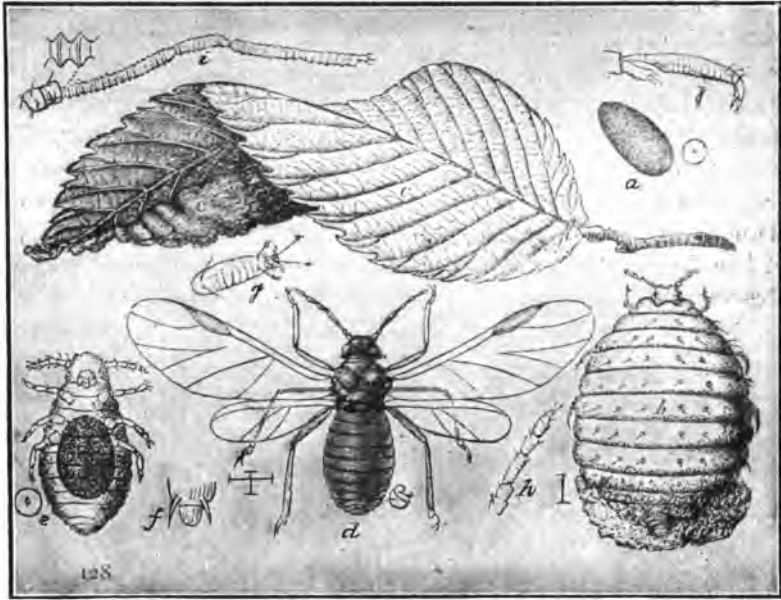
A few small colonies of this louse were found at Oaklandon and near Indianapolis. It does not seem to be of economic importance here. The insects cluster on the under sides of the twigs, especially where some injury exposes the wood, and are completely covered by the woolly wax they secrete, resembling the Woolly Apple Louse in general appearance.

Schizoneura lanigera Hausm.

The Woolly Apple Aphis.

The bunches of white woolly substance on the under sides of apple twigs and limbs were very common on many of the trees examined. While the louse may injure the branches of the tree, its worst damage is done to the roots, on which it forms galls or swellings. After they kill a root, the lice migrate to other living roots. The winged migrants are developed in the fall, and, usually after flying to some other tree, produce living young which are true males and females, and the latter lay one egg apiece in cracks in the bark of the tree trunk. These eggs hatch in the spring, and the production of young again commences. The winged form is about one-twelfth of an inch long, and both it and the wingless form are reddish-brown in color when the wax is removed.

These insects are very easily distributed on nursery stock, and the buyer should be careful that his stock has none on it, or bears no evidence of their work. In the nursery it is probably best controlled by putting a considerable amount of tobacco dust in trenches



THE WOOLLY ELM-LEAF LOUSE, *Schizoneura americana* Riley.

(a) Winter egg. (b) Stem mother. (c) Leaves showing curl. (d) Winged female. (e) True female. (After Riley.)



LEAF CURL OF ELM, CAUSED BY THE WOOLLY ELM-LEAF LOUSE.

(From Patch, Bul. 181, Maine Exp. Sta.)

along the rows. This acts as a fertilizer in addition to killing the aphids and repelling them. For destroying the lice on the branches, either a kerosene emulsion made up to contain 7 per cent. of kerosene, or a tobacco solution such as Black Leaf 40 which has some soap added to make it spread better, should be used, and should be applied with as much force as possible in order to penetrate the woolly substance covering the aphids. Lime-sulphur used in winter will destroy any of the young which may be hibernating on the trunks. When the branches and upper parts of the tree are cleared of lice they can be kept from coming up from the roots by banding the trees with some other substance, as tree tanglefoot, which will



ROOT GALLS OF THE WOOLLY APPLE APHIS.

(From Gillette and Taylor, Bull. 133, Colo. Exp. Sta.)

prevent their crawling up the trunk. Where the roots are badly infested, the dirt should be removed from around the crown of the tree to a depth of six to eight inches, and for a distance of about three feet from the tree. Then 10 per cent. kerosene emulsion or commercial tobacco solution in the right proportions should be sprayed into the hole until the exposed parts and the ground are thoroughly drenched. After using at least two to three gallons to a tree, fill in the earth again, banking it up against the trees. In open porous soil, carbon bisulphide can be injected into the soil, and will kill most of the lice on the roots. At best the root treatment is only temporary and will probably have to be repeated if the lice become bad again. (Plate I, Figs. 9, 10, 11.)



WOOLLY APPLE APHIS ON APPLE TWIGS. (Third Report.)

Longistigma caryae Harris.

The size of this plant-louse will easily distinguish it from any others found in the State, as it is the largest one which occurs here. It is one-fourth of an inch long, and brown or blackish. It was reported but once, from Cass County, on basswood. It also occurs on hickory.

Melanoxantherium smithiae Monell.

This species is dusky reddish in color and about $\frac{3}{24}$ of an inch long. It occurs on willow on the woody stems, and on the young shoots if it is numerous. Only one record was obtained, from Oaklandon.

Melanoxantherium salicis Linn.

The Spotted Willow-louse.

What seemed to be the wingless female of this species was found at the same time as the preceding, but on another species of willow. It is called the Spotted Willow-louse on account of the large whitish spots on the upper side of the body. The length is at least one-eighth of an inch.

Chaitophorus aceris Linn.

The Maple Chaitophorus.

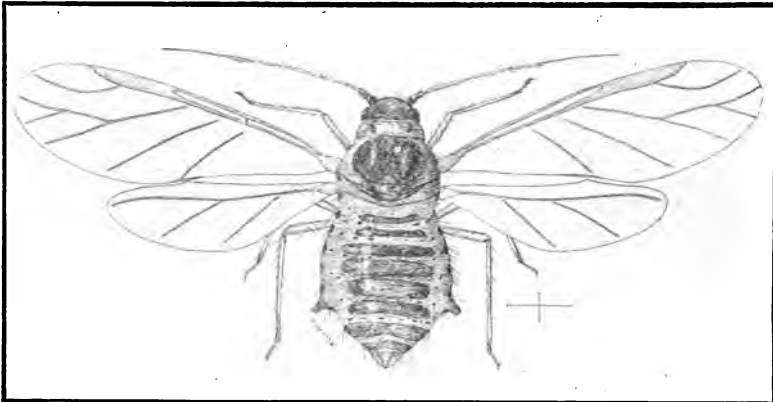
For a time in June this louse attracted much attention in Indianapolis and other cities in the State. The lice are pale greenish-yellow with the top of the body more or less blotched with brown, and with red eyes. They had a habit of clustering on the under sides of the leaves near their bases, and along the leaf petioles, and when they became numerous enough they even formed colonies on the upper sides of the leaves. The honey-dew which they secreted attracted most of the attention which was bestowed on them. The upper sides of the leaves of whole trees were coated with a shiny, somewhat sticky, substance which glistened in the sunlight. The sidewalk beneath the trees also had many of the little spots on it. After about two weeks of this, the leaves of the Norway maples, which were the most badly infested, began to drop off. Several heavy rains about the last of June washed away all traces of the honey-dew, and about this time a number of natural enemies, especially lady beetles, increased so greatly that the lice practically disappeared for the rest of the summer, only a few isolated colonies remaining on some of the younger trees.

Several attempts to control this insect commercially were watched and were successful in every case. Tobacco solutions were used each time. The increase in the number of natural enemies no doubt helped greatly by destroying all of the lice not killed by the spraying.

Some idea of the amount of attention which this insect attracted may be gained from the fact that this office had an average of twelve calls a day for about two weeks in regard to its attacks, and a lesser number for some time before and after the time when it was most abundant. (Plate III, Figs. 1 and 2.)

Chaitophorus populicola Thos.

The color of this louse is black, with the abdomen clay-yellow, marked with black. The wingless forms are very dark brown, or blackish, with a little lighter yellow in their middle. The young are reddish-brown with a large yellow inverted Y-shaped mark in the middle of the body. It was common around Indianapolis on the Carolina poplar during the summer.



WINGED VIVIPAROUS FEMALE, *Chaitophorus populifoliae* Oestlund. (Original.)

Chaitophorus populifoliae Oestl.

This aphid was found on the under side of leaves of Carolina poplar near Indianapolis. It has the front part of the body black, and the abdomen pale green with eight cross bands.

Chaitophorus viminalis Monell.

This is a black species, with a pale green abdomen marked with black bands, and sometimes almost wholly black, and with a row of black spots on each side. The wingless forms are pale green or

yellowish, with long hairs on the body. It was found around Indianapolis, at Oaklandon and at Noblesville, and probably occurs throughout the State.

Callipterus asclepiadis Monell.

This little insect, about one-sixteenth of an inch long, was very common on the under side of leaves of the milkweed (*Asclepias syrica*). It is pale yellow, and the wings usually have dark blotches on them. It was found around Indianapolis and in the northern part of the State, so it is probably general in distribution.

Callipterus bellus Walsh.

The distinguishing mark of this insect is the black or dark band along the front edge of the wing. It is also pale yellow in color. This was a common species on the under side of leaves of white oak around Lake Wawasee.

Callipterus caryae Monell.

This is another pale yellow species without any cornicles or "horns" on the abdomen, and with clear wings, which was found on the under side of the leaves of hickory at Lake Wawasee about the middle of July.

Callipterus discolor Monell.

This occurs on the under side of the leaves of white oak. It resembles the insect found on milkweed in having spotted wings, but the abdomen has several conspicuous dusky cross bands. This was found in small numbers, both at Noblesville and at Lake Wawasee.

Callipterus punctatus Monell.

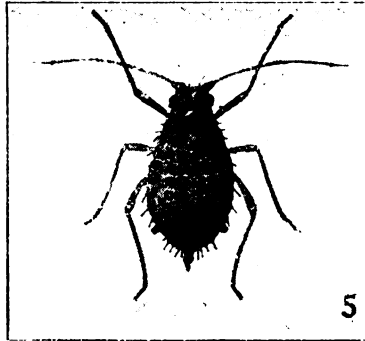
This is still another pale yellow insect which is also found on the under side of white oak leaves, but the wings in this form are not spotted, and have the front margin pale. It was found only at Noblesville in June.

Callipterus trifolii Monell.

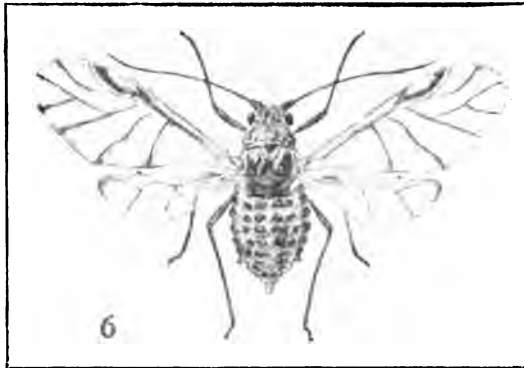
The Clover Callipterus.

This is a yellow species which is found on clover, usually fairly commonly. None were observed during the past summer, but it was very easily found two years ago, when the Green Pea Louse was

so abundant on clover. The abdomen of this species has six rows of dusky tubercles running lengthwise. As with the other species of *Callipterus*, this is usually solitary, only a small number occurring on a leaf. It was found at McCordsville two years ago.



THE CLOVER CALLIPTERUS, *Callipterus trifolii* Monell.
Wingless viviparous female. (From Folsom, Bull. 134, Ills. Exp. Sta.)



THE CLOVER CALLIPTERUS, *Callipterus trifolii* Monell.
Winged viviparous female. (From Folsom, Bull. 134, Ills. Exp. Sta.)

Monellia caryella Fitch.

In color this resembles the above species rather closely, but the wings are laid flat on the body, which is itself somewhat flattened, while in all the others similar to this the wings are held roof-like, with the hind edges touching above the body. A few specimens were found at Lake Wawasee on young shellbark hickory trees about the middle of July.

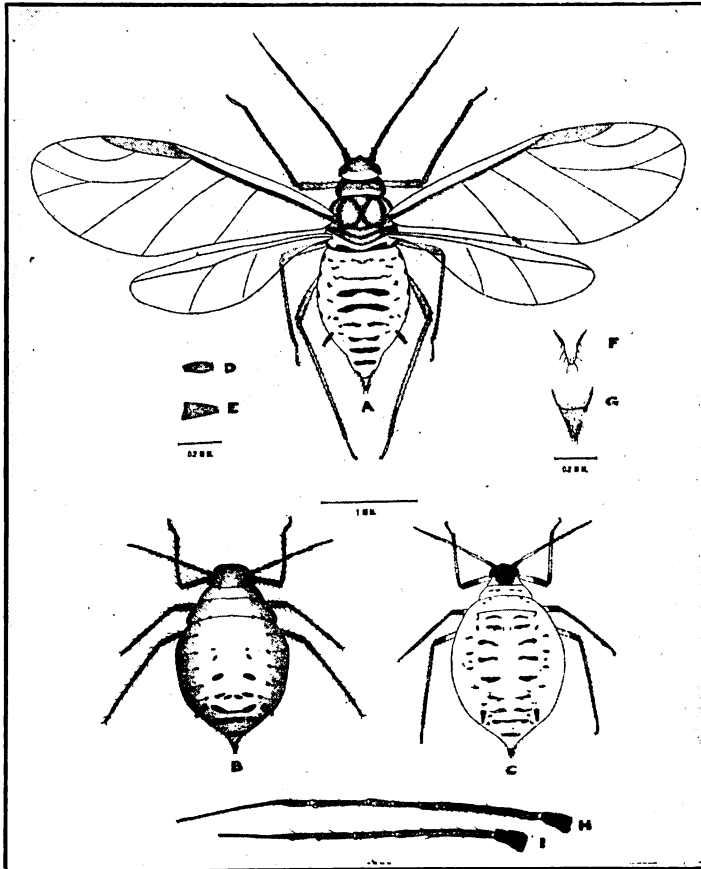
Drepanaphis acerifolii Thos.

This was common throughout the State on soft maple, and is occasionally found on hard maple. It is brown with a pale yellow to brown abdomen marked with black across the middle. The eyes are bright red. There are two pairs of spines or tubercles in the middle of the abdomen, either one or both of them black, which readily distinguish the species. The second pair is the longer, and the two spines are slightly united at the base.

Aphis brassicae Linn.

The Cabbage Aphis.

Nothing is a much commoner pest of cabbage than this insect. Usually the parasites are numerous enough to prevent serious dam-



THE CABBAGE APHIS, *Aphis brassicae* Linn.

(a) Winged viviparous female. (b and c) Wingless viviparous females, etc. (From Essig, Pomona Journal of Entomology, Vol. III.)

age, but in spite of them the lice frequently break forth and damage the young plants especially. The winged females are yellowish-green in color, with much of the front part of the body black. The wingless forms are pale grayish-green, but are almost always covered with enough whitish meal to hide the true color. The body usually has a row of black spots down each side, and often other black flecks in addition. It was found near Indianapolis, and is probably all over the State.

The most important thing in the control of the Cabbage Aphis, as in the control of most of the cabbage pests, is to clean up the fields or patch thoroughly in the fall after the eggs are laid on the leaves and stubs. If these are destroyed, all the eggs are removed, and any hibernating places are destroyed at the same time. When the lice become abundant enough on the plants to need spraying, any of the standard remedies may be used, such as kerosene emulsion or Black Leaf 40. These should be sprayed on with considerable force in order to penetrate the mealy covering of the lice.

Aphis cephalanthi Thos.

The Button-bush Aphis.

Both the wingless and winged forms of this louse were found at Wawasee on the 18th of July. The winged form is black with a brown abdomen, with little waxy secretions along the edge.

Aphis forbesii Weed.

The Strawberry Root-louse.

Strawberry beds are often infested with this louse which causes the plants to wither and die. The aphids are about 1/20 of an inch long and dark green or blackish in color. Most of the injury is done in light sandy soil. The insects attack the roots, often covering them completely. The tiny eggs may be found along the stems and mid-ribs of the green leaves in fall and winter. They are black and shining. The young lice which hatch from these eggs in the early spring begin to form colonies on the tender leaves of the crown of the plant. In two or three weeks the ants which are the constant attendants of these lice, appear and carry the aphids down onto the roots of the plant. These ants protect the plant lice during the summer and take them to new food plants when the old ones die.



TWO STRAWBERRY PLANTS.

The smaller showing the effects of the attacks of the strawberry root-louse, *Aphis forbesii* Weed.

There are some parasites which help greatly in controlling this insect and keep it from becoming fatal to whole strawberry beds. In addition, there are some more or less successful control measures which may be practiced. Plants that are not infested should be secured, and they should be planted on land that has had no infested plants on it. The plants can be disinfected by delaying the planting till all of the eggs have hatched, and then dipping the plants for a few minutes into dilute tobacco extract solution. Where a new bed is to be planted near an old one, the latter should be destroyed the previous fall to prevent the winged lice from migrating to the new plants. Perhaps the best way to lessen the numbers of lice in an old bed is to burn it over carefully with a quick hot fire. This should be done in early spring by spreading straw or grass over the bed just as the plants begin to grow and setting fire to this. This burning over kills all the young lice and the eggs as well, and is beneficial in other ways.

This louse has been found in several scattered localities in the State and is probably distributed all over it.

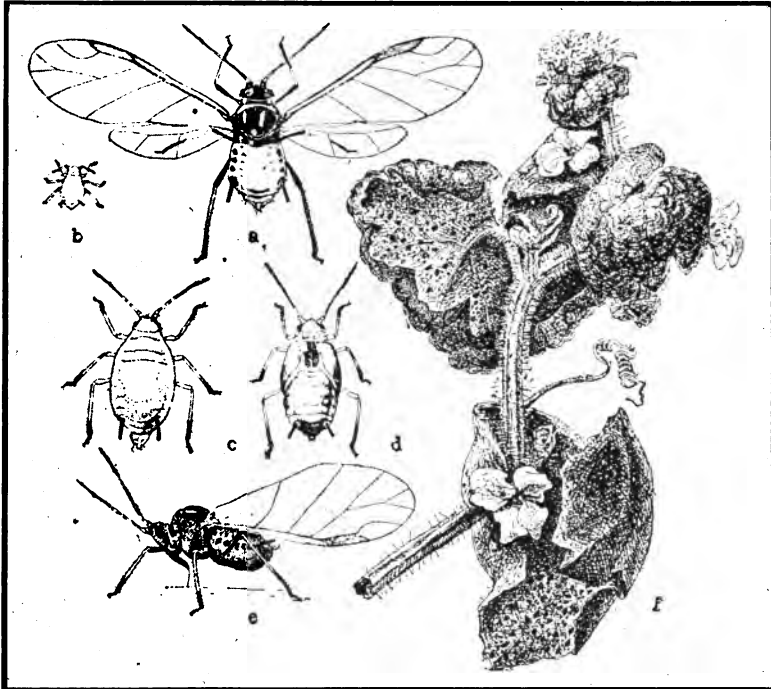
Aphis gossypii Glover.

The Melon Aphis.

This louse does the most damage to melons, causing the leaves first of the young shoots and later the whole plant to curl up and then to wilt. It probably has the greatest variety and the most food plants of any species found in the State. As soon as the melons start their growth, usually, the lice migrate to them from nearby weeds on which they commenced to develop in the spring. The color of these lice is very variable, ranging from light yellow to an almost blackish-green. They are about 1/15 of an inch long. The winged form is black, with the abdomen varying in color like the wingless mentioned above, and with a row of black spots down each side, and with the "horns" or cornicles of the abdomen black. It is common on melons around Indianapolis, but did not seem so abundant as usual this year. In the early summer this species was a very serious pest of nasturtiums. It clustered on the under side of the leaves near their bases and was so common that many beds were almost wholly destroyed. Black Leaf 40 was used very successfully on these plants. It was also found on gourds in the city about the middle of September.

The control of this insect is helped greatly by the many parasites which attack it. Artificial methods of control are usually

necessary in spite of the numerous natural enemies. One of the most important things to do in controlling the louse is to watch the vines carefully and when one is found which is very badly attacked, to destroy it completely in such a way that the lice are all killed. Spraying should be done as soon as the lice are observed, as it is almost impossible to spray for the pest successfully after



THE MELON APHIS, *Aphis gossypii* Glover.

- (a) Winged female from above. (b) Newly hatched young aphid. (c) Adult wingless female.
 (d) Nymph at last stage. (e) Winged female from the side. (f) Melon leaves showing
 aphids on them, and the curling of the leaves. (From Chittenden, Cir. 80,
 Bureau of Entomology, U. S. Dep. of Agr.)

the leaves are badly curled. Tobacco extracts or kerosene emulsion should be used for spraying, and an underspray rod, or the vines should be turned over to be sprayed. Black Leaf 40 diluted one part of the tobacco solution to fifty parts of water has been reported as very effective in controlling this louse. Kerosene emulsion should be made very carefully to prevent injury to the foliage.

Fumigation is usually the most reliable and effective method of combating the melon aphid. Either carbon bisulphide or tobacco fumigation sheets may be used. The latter are probably the most

satisfactory. If only a few vines are to be treated, inverted tubs or large buckets may be used to cover them, and about a teaspoonful of carbon bisulphide evaporated to every cubic foot of space under the tub. When many plants are to be treated, it is much better to make light frames wide enough to take in the whole plant, and long enough to cover two or three. These may be about 4 by 6 feet, and from 8 to 12 inches high. The frames should be covered with cheap closely woven muslin which is to be soaked in linseed or other oil. The muslin should be cut long enough to leave about a foot free around the edges. The frames should also have cross-slats nailed on their tops for convenience in handling. The frames are placed over the vines and earth piled on the projecting flaps of cloth most of the way around. Then the tobacco sheet to be used is torn up into strips and put under the frame in a tin can, after which it is lighted, and the covering of the cloth flap completed. The fumigation should continue for from ten to thirty minutes, depending on the results. Fumigating powder may be used in place of the sheets. The complete destruction of the vines as soon as possible after the crop is harvested is also very helpful, as many of the lice are destroyed in this way.

Aphis houghtonensis Throop.

This was found by Professor J. Throop near Indianapolis in 1904 and 1905. The wingless forms are pale green, about 1/16 of an inch long, and hairy. The winged forms are about as long, slightly darker green, and not hairy. This louse curled the leaves of Houghton gooseberry very badly.

Aphis helianthi Monell.

The Sunflower Aphis.

The wingless forms were common on the sunflower during most of the summer. They are green, varying from pale to dark, and more or less shaded on the abdomen. This species was found around Indianapolis.

Aphis maidis Fitch.

The Corn Leaf Aphis.

This louse was not reported to the office during the past year, but it is included in Hunter's Catalogue, and is probably common over the State. It is bluish-green in color, about 1/12 of an inch long, and appears in the latter part of the summer.



Aphis helianthi Monell. ON SUNFLOWER LEAF. (First Annual Report.)

Aphis medicaginis Koch.

This was a very common species on an undetermined legume at Lake Wawasee. The winged forms are black, with a blackish-green abdomen. The wingless forms are shining black when full grown and their appearance as they stand out among the dull young is quite characteristic.

Aphis persicæ-niger Smith.

The Black Peach Aphis.

This louse attacks both the roots, the young shoots and the leaves of the peach. As with the Woolly Apple Louse, most of the damage is to the roots, although it frequently becomes bad on the foliage. The full grown wingless lice are about 1/12 of an inch long and very dark brown or black in color. The young found on the leaves and stems are reddish-yellow. Only the wingless forms are found on the roots, and they continue to grow and produce young through the year. In the spring some of them migrate to the foliage and begin colonies there. From a few small colonies they may spread over the whole tree.

As the lice are firmly attached to the roots, all nursery stock should be examined to see that there are none on its roots. Tobacco dust in the nursery rows, as suggested for the Woolly Apple Louse, should help to prevent injury to nursery stock, while the roots of trees that are attacked should be treated as suggested for the Woolly Apple Louse. It may be controlled on the leaves and branches by spraying with any of the sprays usually used. Young shoots which are found with lice on them in spring should be destroyed. (Plate I, Figs. 12, 13, 14.)

Aphis pomi DeGeer.

The Green Apple Aphis.

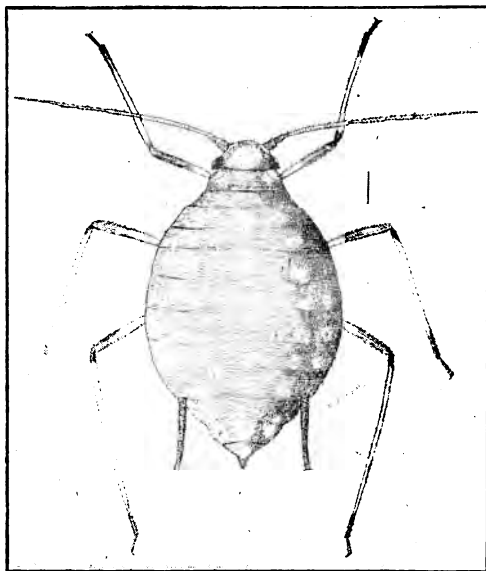
This pest of the apple and pear was very common over the whole State during the past year, the attacks continuing through the summer. The injury to the young trees is the most serious, as the leaves are first badly curled and then drop off. On old trees the leaves are often badly curled, but the damage is not so great as on the young trees. The black, shining, oblong eggs are very common in winter on the twigs, in crotches and bud axils of badly infested trees. These eggs hatch in the spring just before the buds open, and start colonies which continue to grow and produce wingless and winged migrating forms through the summer.

Winter spraying with lime-sulphur as for the San Jose scale has been reported as destroying the eggs of this and other species of apple plant-lice, but there are some experiments reported which were not successful. The lime-sulphur will do no harm, and will probably be of value in most cases. For the Green Apple Aphis, as

for other species which curl the leaves, spraying should be done before the insect has curled the leaves, as successful spraying is then impossible. Tobacco extracts, kerosene emulsion containing 7 per cent. kerosene, whale oil soap at the rate of 5 to 6 gallons of water to 1 pound of soap, or dilute miscible oils are successful in controlling this and other lice affecting the apple. Care should be used in spraying to reach all of the insects, and good pressure is necessary to do this successfully. (Plate I, Figs. 1 to 8.)

Aphis populifoliae Fitch.

Only the wingless forms of this aphis were found. They occurred on the tips of sprouts of the quaking aspen at Lake Wawasee.



WINGLESS VIVIPAROUS FEMALE, *Aphis populifoliae* Fitch. (Original.)

The color is dark reddish-brown to blackish, with several spots of white pulverulence on the body. The cornicles or "horns" are much longer than in most similar species.

Aphis rumicis Linn.

The leaves of a species of *Atriplex* were curled and twisted by this insect. It was found only once, at Noblesville, and then in small numbers. It is a rather large, black aphid with a dark green abdomen, which has several black stripes across it.

Aphis setariae Thos.

The Rusty-Brown Plum Aphid.

This rusty-brown species was abundant on plum in several places around Indianapolis during June. It attacks the young

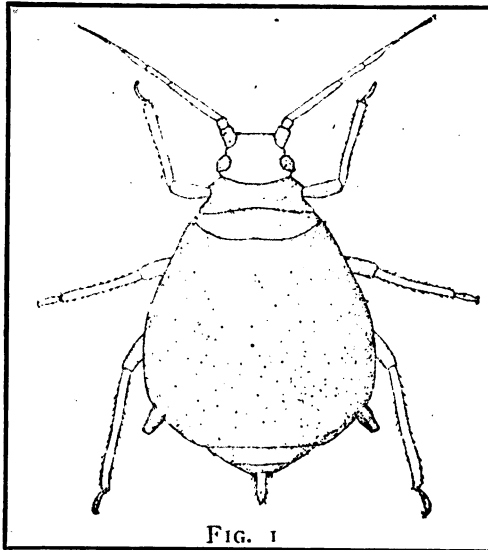
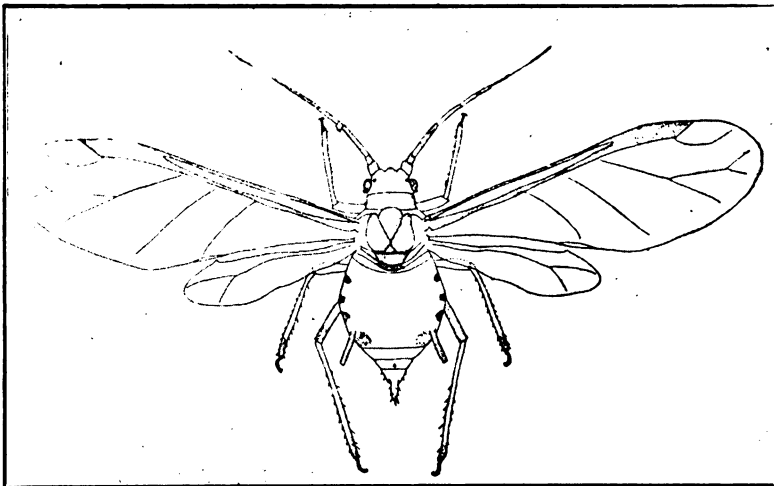


FIG. 1

THE RUSTY-BROWN PLUM APHIS, *Aphis setariae* Thos.

Wingless viviparous female. (From Sanborn, Bull. 88, Oklahoma Exp. Sta.)



THE RUSTY-BROWN PLUM APHIS, *Aphis setariae* Thos.

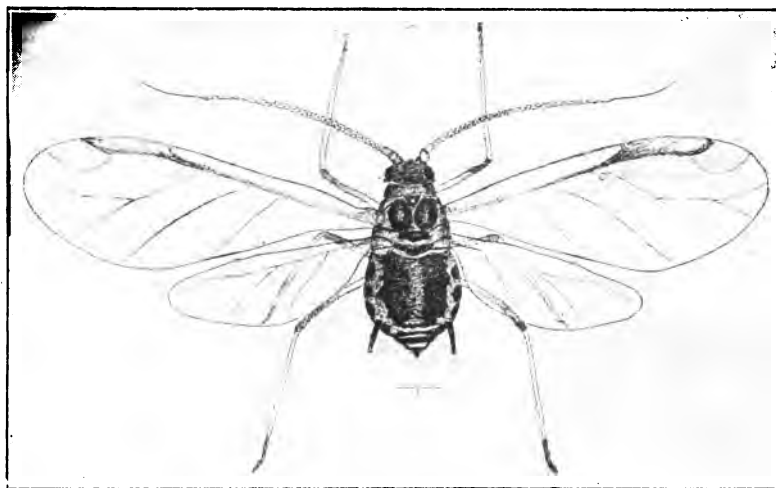
Winged viviparous female. (From Sanborn, Bull. 88, Oklahoma Exp. Sta.)

shoots and the leaves, clustering on the under sides of the latter, and curling them, and at times even attacks the blossoms and keeps the fruit from setting. Late in June reports of the attacks ceased, making it evident that the winged lice had migrated to one or several of the grass plants which are their food during the summer. In the fall they again migrate back to the plum to lay their eggs. These lice can be controlled on the plum by spraying as soon as they are found, with one of the standard remedies.

Aphis sorbi Kalt.

The Rosy Apple Aphis.

This louse was reported as rather abundant from two or three places around Indianapolis during June of the past summer. The wingless females are variable in color, ranging from salmon color



THE ROSY APPLE APHIS, *Aphis sorbi* Kalt.

Winged viviparous female. (From Sanderson's Insect Pests of Farm, Garden and Orchard.)

to purplish or black, with a bluish powdery substance covering the body. They are noticeably larger than the Green Apple Aphis. Their habits are like those of the Green Apple Aphis at first, and they may be controlled in the same way. In the summer, however, the winged forms migrate to some unknown food plant, and remain till fall, when they return to the apple and lay their eggs.

Aphis spirellæ Schout.

The insect that has been called by this name was very common during much of the summer on Spirea at Indianapolis, infesting the terminal shoots and the leaves. It looks almost exactly like a small Green Apple Aphis.

Aphis vernoniæ Thos.

This is a small dusky aphid with a pale yellow abdomen which was found on ironweed at Noblesville about the middle of June.

Cerosipha rubifolii Thos.

This species was found on wild blackberry both at Wawasee and at Indianapolis. It is a very small, black, with a pale yellow-green abdomen, which is mottled with blue-green, and has five jointed antennæ or "feelers," while all of the similar species have the antennæ six jointed. The wingless form is pale yellowish-green, with the body mottled with blue-green. It is found on the under side of the terminal leaves of the shoots, causing the leaves to wrinkle and curl and to bunch up.

Toxoptera graminum Rond.

The Spring Grain Aphis or Green Bug.

This louse was not reported to the office during the past year, but it has been found in the State by F. M. Webster and others, and is one of the three species reported directly from the State in Hunter's Catalogue of the Aphididæ of North America. It is yellowish-green in color, varying in size from 1/25 to 1/14 of an inch. When it once gets a start it increases very rapidly in numbers. Certain parasites are very helpful in controlling the insect. The destruction of volunteer oats and wheat in the early fall is the most effective method of controlling the louse.

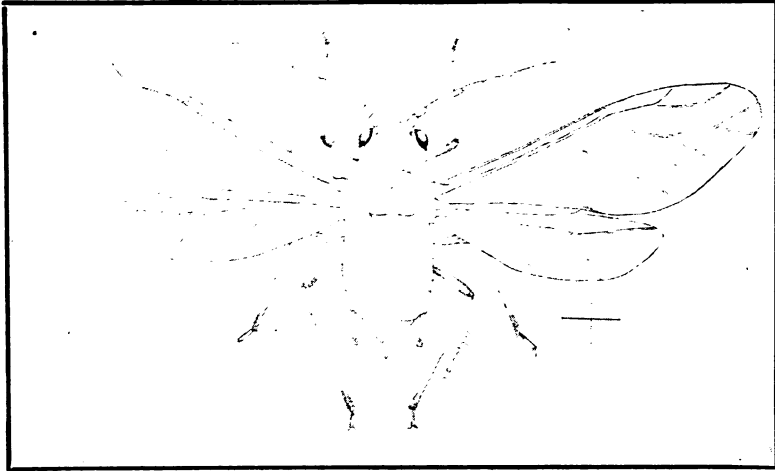
Toxoptera muhlenburgii Davis.

This is another grass aphid which has been found recently by Phillips and Davis at Richmond and Lafayette.

Hyadaphis pastinacæ Linn.

This is a species which was abundant on *Pastanica sativa*, a very common roadside weed. It clustered on the upper parts of

the stalks and on the flower umbels. It is green, with black markings on the abdomen, and with the head and thorax black. It was found around Indianapolis early in July.



WINGED VIVIPAROUS FEMALE, *Hyadaphis pastinacæ* Linn. (Original.)

Rhopalosiphum rhois Monell.

This is a reddish-brown aphid which is sometimes common on the ornamental sumach. It was found on the young flower stalks of sumach grown in a nursery at Lafayette.

Myzus cerasi Fabr.

The Black Cherry Louse.

This is a deep shining black species that often becomes abundant on cherry. It was found near Indianapolis, in small numbers, about the time that the late cherries were ripe. It clusters on the young shoots and on the under side of leaves. Spraying with the remedies as suggested for the Green Apple Aphis should control this pest if it becomes very bad. (Plate II, Figs. 1-3.)

Myzus persicæ Sulz.

The Green Peach Aphis.

This louse was common on peach around Indianapolis during the last of May and the first of June. On the peach the form is pink when first hatched from the eggs. These pink individuals

give birth to pale green forms, which in turn raise mostly winged forms which are greenish with a large black blotch in the middle of the abdomen, and with the head and thorax black. The winged forms fly to a great variety of plants, including cabbage, tomatoes and many other vegetables as well as a number of weeds. In the fall they fly back to the peach trees, after raising several generations of young on the summer host plants. The eggs are then laid on the peach by sexual forms. The summer and the spring forms are very similar, except that the "horns" or cornicles of the summer forms are swollen near the outer end, while in the forms on the peach they are straight.

The trees known to be infested with the lice should be sprayed about a week before the buds open with one of the standard sprays. If the foliage is found to be affected the same remedies may be applied to it. This insect was also very abundant on nasturtiums along with the Melon Aphis, and was destroyed by spraying in the same way as was that species. (Plate II, Figs. 4-11.)

Myzus rosarum Buckt.

Specimens of this louse were common, but never numerous, on the under side of leaves of roses at Indianapolis during most of the summer. The insect has a green abdomen with black cross bands. The wingless forms and the young are apple-green, and the latter have long hairs with little knobs on their ends arranged in rows over the body.

Phorodon humuli Schrank.

The Hop Aphid.

Wingless specimens of this aphid were brought in once from Indianapolis in July. It is pale green to apple-green in color, and has two prominent, almost spine-like humps on the front of the head, one just inside of each antenna or "feeler." It was found on the leaves of the hop plant.

Macrosiphum erigeronensis Thos.

This is a rather long, slender form, pale green in color, which was common on white-top (*Erigeron canadense*) during the early part of the summer. It was found at Lake Wawasee, at Noblesville and near Indianapolis, so it is probably distributed over the whole State.

Macrosiphum lirodendri Monell.

The Tulip-Tree Aphid.

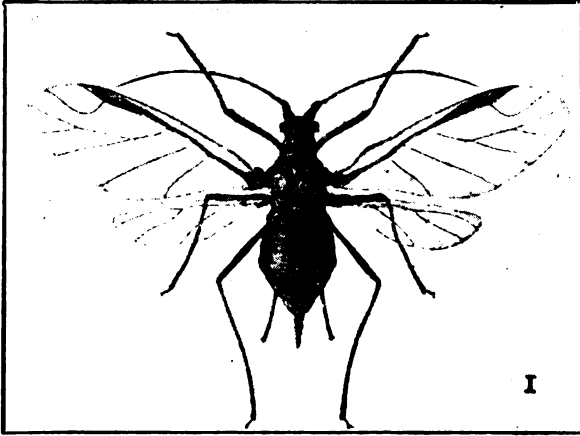
The leaves of several tulip trees in Indianapolis were badly infested with this louse late in June and during July. While there is usually a little dropping of the leaves at this time, this was greatly increased by the attacks of the plant-lice. The winged forms are a reddish-brown, with the abdomen pale green. In addition to this form there is a variety which is pale reddish in color, specimens of which are usually scattered among the lice on the lower sides of the leaves. Some of these tulip trees were sprayed commercially with a prepared tobacco solution, and the plant-lice were practically exterminated. At the time this was done, there were a great many lady beetle larvæ among the lice. When the trees were examined a few days later, there were dozens of the pupæ of the lady beetles scattered over the leaves, twigs and trunks. Later on the adult beetles emerged, and they probably helped greatly, both as larvæ and as adults, in making the spraying seem so effective.

Macrosiphum pisi Kalt.

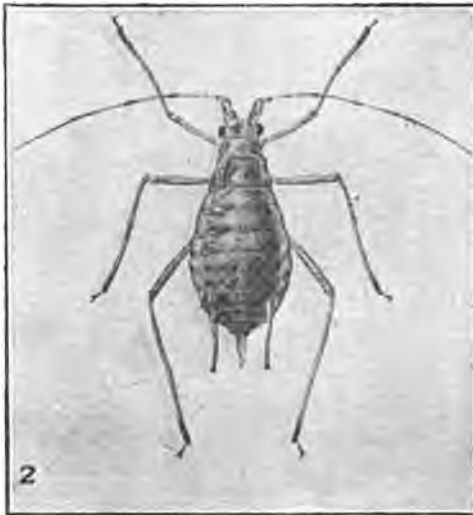
The Green Pea Aphid.

This is a large green louse which is very abundant on garden and sweet peas, clover and other related plants. It was found in many city yards in Indianapolis during the past summer, and two years ago was so common in many clover fields near the city that the clover remained on the ground for more than a week after cutting without showing any signs of curing. The clover stems were so plastered with honey-dew that the moisture could not evaporate from them. When such a condition is threatened, the clover should be cut even before it is ready, as it will cure before the lice have attacked it badly, and many of the lice are killed by the destruction of their food plant. This insect has a number of natural enemies which help to keep it from becoming too great a pest. The most important of these is a fungous disease which acts best in damp weather, but has hardly any effect in dry weather. On sweet peas or on a few vines of garden peas any of the usual remedies will be effective. Where city water pressure is available, turning the hose on the vines with as strong a stream as possible in an effort to knock off all the lice has been recommended. What

few experiments we tried this way were not very successful, but it might control the insects if repeated frequently. Spraying with a traction sprayer, using whale oil soap or some of the tobacco solutions should be tried on large fields. It is a rather expensive method, but ought to save the crop if it is done properly.



THE GREEN PEA APHID, *Macrosiphum pisi* Kalt.
Winged viviparous female. (From Folsom, Bul. 134, Ills. Exp. Sta.)

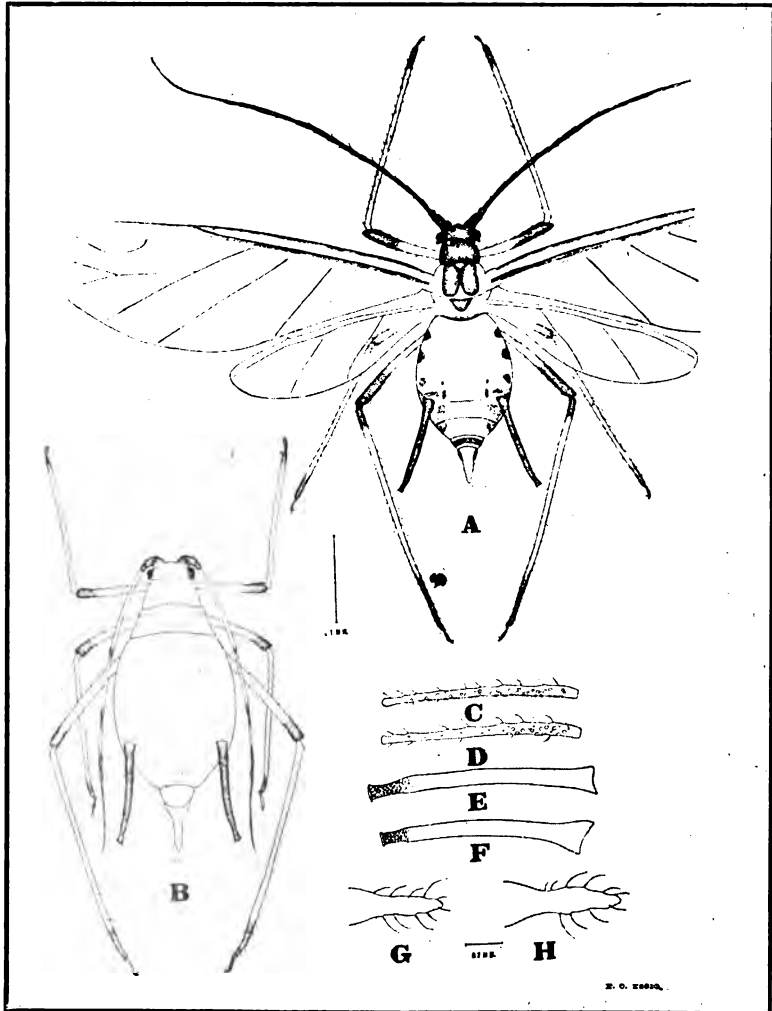


THE GREEN PEA APHID, *Macrosiphum pisi* Kalt.
Wingless viviparous female. (From Folsom, Bul. 134, Ills. Exp. Sta.)

Macrosiphum rosæ Linn.

The Rose Aphid.

This is usually a common insect on the rose, but curiously enough it was very infrequent during the past summer in many



THE ROSE APHID, *Macrosiphum rosæ* Linn.

(a) Winged viviparous female. (b) Wingless viviparous female, etc. (From Essig, Pomona Journal of Entomology, Vol. III.)

places where it is ordinarily abundant. This species also has two color varieties, one pale to apple-green, the other pink or reddish. The two are often found intermingled on the young stems and the



Macrosiphum rudbeckiae Fitch. ON GOLDEN GLOW. (First Annual Report.)

larger leaves. The insect prefers the stems and buds. The cornicles or "horns" of the abdomen are very long and blackish or black. It has been found all over the State.

Macrosiphum rudbeckiae Fitch.

The attack of this louse is most frequently noticed on the Golden Glow, although a number of other composites, both wild and cultivated, are often infested by it. The typical form of this louse is wine-red in color, but the color is very variable from this to dark brown, or shining blackish-brown. Specimens of what is called *Macrosiphum ambrosiae* were also found on several composites, but it seems impossible to tell the two apart, so they are both included here. This species was also found everywhere in the State.

Macrosiphum sanborni Gillette.

The Brown Chrysanthemum Aphid.

This is a very dark brown or blackish species which is usually common on chrysanthemums in greenhouses. It was found in several Indianapolis greenhouses.

Macrosiphum solanifolii Ashmead.

The Potato Louse.

A few specimens sent in late in June from near Indianapolis form the only record we have for this species. It is a large, green form, occasionally reddish, which closely resembles the species found on the sweet pea and other legumes. *M. solanifolii* occurs largely on the potato, but it is also found commonly on the legumes and upon some other plants, as Shepherd's Purse.

Macrosiphum viticola Thos.

The tender leaves and young shoots of the grape, both wild and cultivated, are often attacked by this insect. It varies greatly in size, the smaller specimens looking a great deal like specimens of Aphis. The color is blackish, with the abdomen dark brown. The wingless forms are dark brown. It was found at Lake Wawasee about the middle of July and at several places in and around Indianapolis during the summer.

SOME POINTS ON THE CONTROL OF PLANT DISEASES.

There are a few fundamental principles in the controlling of plant diseases which should be taken into consideration. In the first place one should have at least a little knowledge of plant physiology and appreciate the damage that is being done when any part of the plant is diseased to such an extent that it cannot properly perform its function. The orchardist or farmer should also be familiar with those conditions that favor the welfare of the plant, such as proper cultivation and fertilization, as well as those conditions that favor the development of the fungous diseases. To intelligently combat any particular disease, some conception of the life history of that disease is essential. Since climatic conditions vary so much in the different latitudes, as well as during the different seasons it is quite important that in order to combat a disease to the best advantage that some knowledge of its life history be acquired. Great care should exist in the preparation and application of the fungicides.

It is a well-known fact that certain varieties of plants are more or less resistant to certain diseases. The reason for this is not well understood but the fact remains. In Indiana the Smith Cider and Mann apples are particularly susceptible to the attacks of apple blotch. Brown rot which causes so much destruction of stone fruits does not attack the Marietta and Wild Goose plums to any great extent. The Early Harvest variety of blackberry is usually badly affected with orange rust while the Snyder variety of black raspberry is quite resistant to this trouble.

In connection with the treatment of any fungous trouble general sanitation should not be overlooked, for since the spores of the disease may be harbored upon the leaves, twigs or cankers on the branches, it is evident that these sources of infestation should be intercepted. Where the soil becomes infected crop rotation should be practiced.

The chief means of control is spraying. The most common mistake in the application of a fungicide is made by applying it too late. The organism producing the disease can very seldom be killed after it has started its growth upon the host. Careful watch should, therefore, be maintained and when conditions are right for

the spores to be discharged or when the first evidence of the trouble shows itself the fungicide should be applied—not for a cure but to prevent infection. Possibly the only exception to this may be in connection with the powdery mildews. Although they cannot be eradicated by spraying after they have become established, yet they may to a considerable extent be held in check on account of the superficial nature of their growth. Growth that is taking place within the tissue of the host, however, will not be killed by fungicides. Germinating spores on the surface may be killed if they are caught before the growth has penetrated the tissue. It is evident, therefore, that in spraying for fungous troubles the operation should precede the occurrence of the disease.

There is a great difference in the resistance of different host plants to spray injury and it is therefore essential that the strength of the solution be regulated according to the host plants on which it is applied. Climatic conditions always seem to have a great influence upon the injury produced by the spray solution. This still provides a large field for investigation.

SOME IMPORTANT DISEASES OF APPLE.

The following discussion of apple diseases is designed to enable the orchardist to recognize any one of the diseases described without having to subject it to a laboratory examination. It is often very difficult to distinguish some of the troubles from the cankers alone especially in their early stage of development. In their later stages, however, they are quite characteristic and those affecting the tree as cankers, leaf spots and also producing diseased fruit, may often be diagnosed by observing their appearance on the various parts of the tree. Technicalities are avoided as far as possible throughout the entire discussion of plant diseases in this report.

APPLE SCAB.

Venturia Pomi—(Fr.) Wint.

This disease is very destructive to fruit in Indiana and also in the other middle western States. It is very widely distributed and in any part of the country where scab does not have a foothold it is because the apple is not generally grown. Cool and damp weather, either during the spring or summer furnishes a favorable condition for the development of this disease.



APPLE SCAB ON LEAVES.

The loss from apple scab is tremendous. Infested fruit must be sold at a greatly reduced price and the number of bushels is much reduced as a result of this trouble. The loss is heavy each year and the average of every second year, according to a conservative estimate, destroys from 25% to 50% of the crop. The fruit and leaves are most commonly affected, but the leaf stalk, flowers and twigs are not exempt from the attacks of scab. This disease is very readily recognized on the leaf by the velvety, olive-green blotches caused by it. Both sides of the leaves are likely to be affected. On the fruit small greenish blotches appear at first and later the characteristic scabby surface develops from these blotches. It is believed that the spores develop superficially for a short time and then the fungus penetrates the tissue.

The result of the disease upon the fruit is very characteristic. The affected part ceases to grow and an ill-shaped apple results. In severe infestations deep cracks form across the diseased part of the apple very much like the cracking produced by the apple blotch.

No varieties of apple are entirely free from the attacks of this parasite but certain ones are known to be particularly susceptible.

It is believed that a perfect stage of this fungus is developed during the winter from the infested leaves that fall to the ground. This belief is borne out by the fact that the lower leaves show the disease early in the spring while the upper ones are comparatively free from it. On account of the economic importance of scab a great deal of work has been done by the various experiment stations of every State for the purpose of determining the best control methods. Results of these numerous experiments prove that lime-sulphur at the strength recommended in the dilution table will very effectively control scab. During the past season, which was a very favorable one for the development of scab, it has been found advisable to use the stronger fungicide, Bordeaux, on varieties that do not russet badly. As a general recommendation, however, lime-sulphur should be used for the second summer spray on account of the injurious effects of Bordeaux upon the young fruit.

APPLE BLOTCH.

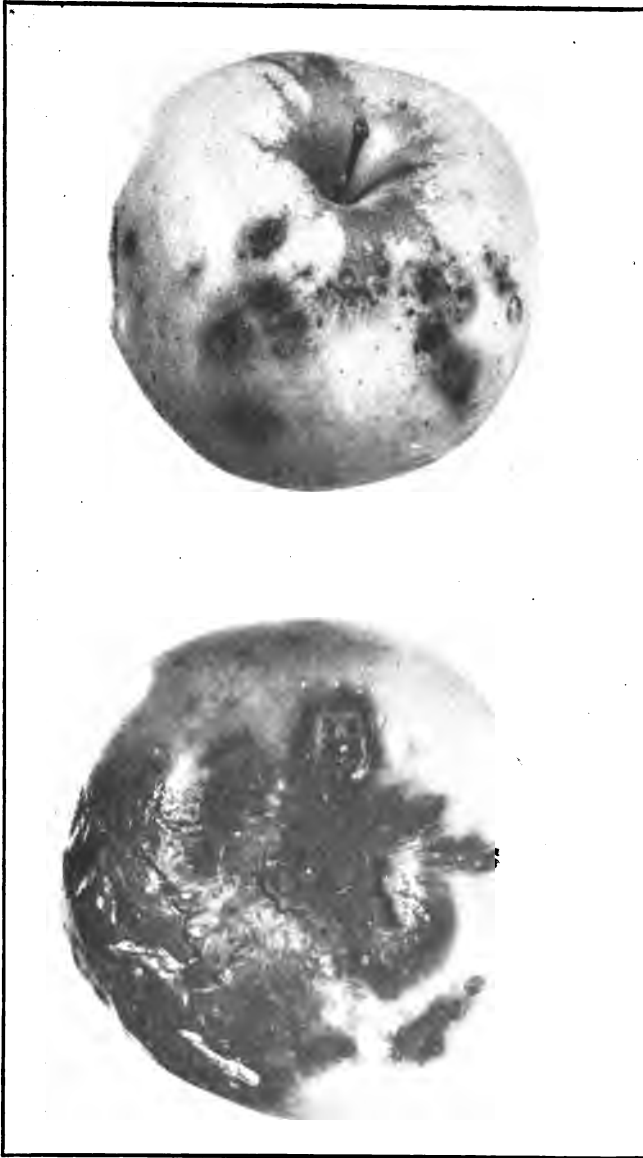
Phyllosticta solitaria—E. and E.

In the southern half of this State this disease has become very serious. The blotches on the fruit as well as the twig cankers are very characteristic of the fungus. Orchardists are annually suffer-



APPLE SCAB ON FRUIT. (Original.)

ing heavy losses principally through the lack of becoming acquainted with the disease and methods for its control. Since lime-sulphur has so successfully controlled scab, it is unfortunate that it will not work equally well against this disease—as blotch is so often confused with scab.



APPLE BLOTCH. (Original.)

Blotch shows on the fruit as small, brown, irregular blotches which grow until they reach a size of from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. The surface of the fruit becomes rigid within the areas of the blotches which causes it to crack much the same as in a bad scab infestation. Smith Cider and Mann are particularly susceptible varieties in Indiana.



APPLE-BLOTCH CANKERS ON YOUNG TWIGS. (Third Annual Report.)

The twig cankers cause the water sprouts, fruit spurs and smaller twigs to have a general roughened or shaggy surface. Small brown areas from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter may be seen and it is in these areas that the fungus passes the winter, and is the source of a re-infection the following year. Tiny black raised points may be seen in the brown area and from these multitudes of spores are discharged early in June.

The small inconspicuous leaf spot caused by this disease is of no particular economic importance and will be controlled along with the fruit treatment. Diseased fruit soon produces spores which when discharged infect other fruit, twigs and leaves.

Great vigilance should be exercised and spraying with Bordeaux should begin as soon as the first tiny brown spot appears on the fruit. The fact that infection shows itself indicates that multitudes of spores are present and very soon a severe outbreak will result if spraying is postponed.

BITTER ROT.

Glomerella rufomaculans—(Berk.) Spauld. and von Schrenk.

The moist and warm season just passed produced ideal conditions for the development of this disease in Indiana and considerable loss was suffered, especially in sections of the southern part of the State. The following discussion of this disease is taken from the U. S. Department of Agriculture, Farmers' Bulletin No. 492. This description, together with the accompanying photographs, should enable one to determine whether or not this disease exists in his orchard.

“ECONOMIC IMPORTANCE: In sections where it is prevalent, bitter rot is the most dreaded of all the common apple diseases. After the fruit has been safely nursed through the attacks of scab and the codling moth and is about ready to be harvested an outbreak of bitter rot may destroy the entire crop of some varieties without much warning. It is rather spasmodic in its appearance, depending largely on weather conditions. Hot weather with plenty of moisture is essential to the rapid development of the disease, and it therefore does not occur to any serious extent in the more northern parts of the apple belt nor in the drier sections of the West. It is well distributed throughout the Southern States where apples are grown, extending into southern Illinois, and has in the past destroyed several million dollars worth of apples during a single

season. However, in recent years, since its treatment has been better understood and more thoroughly put into practice, the annual losses have not been so great.

“CHARACTER OF THE INJURY: The bitter-rot disease appears on the fruit as a circular brown spot with concentric rings of fruiting pustules. The young spots are very small and often show pur-



A BITTER ROT CANKER. (Second Annual Report.)

plish or reddish margins, but under favorable conditions they rapidly enlarge, involving the entire apple in decay. The disease extends inward toward the core at about the same rate as the spread on the surface, forming a cone-shaped area which can be easily crushed out with the fingers. Owing to the shrinking of the invaded tissues, the spots become somewhat sunken, and this distinguishes it from black rot and brown rot. Several spots, or, in

severe cases, several hundred spots, may occur on the same apple, although one spot is sufficient to destroy the whole fruit.

“CAUSE OF THE DISEASE: Bitter rot is caused by the fungus *Glomerella rufomaculans* (Berk.) Spauld. and Shrenk, which invades the tissues of the apple, producing the familiar spots described above. It passes the winter in cankers on the limbs and in mummied fruits. Under favorable weather conditions spores from these sources and perhaps from unknown sources infect the



BITTER ROT OF APPLE. (Third Annual Report.)

fruit, starting an outbreak of bitter rot. When the germ tube, resulting from the germination of a spore, finds its way through the skin of the apple, it immediately begins to branch and grow rapidly, obtaining its food supply from the tissues and causing these to die and turn brown. After a time clusters or tufts of fruiting branches are formed and these burst through the skin in rings, producing pink masses of spores which serve to spread the disease to other apples. Millions of spores are produced from a single spot, so that under favorable conditions the entire crop of an orchard may become diseased from one center of infection.

"In addition to the summer spores or conidia, there are produced on the mummied fruits and in limb cankers winter spores or ascospores, which constitute the perfect stage of the fungus. It is not definitely known that these ascospores play any important part in the life history of the fungus.

"**THE LIMITING FACTORS:** Barring preventive measures, the two limiting factors determining bitter-rot outbreaks are weather conditions and varietal resistance. Heat and moisture are essential to the vigorous growth of the fungus, and of these two heat is the more important. While hot, showery, or muggy weather is ideal for the development of the fungus, serious outbreaks of the disease may occur during comparatively dry weather, providing the temperature is high and the dews are heavy at night.

"Infections may take place at any time during July, August, and September, but rarely earlier or later. High summer temperatures are required for the rapid growth of the fungus, and these are the months in which such temperatures usually occur. Infections may begin to take place during the latter part of June if the weather conditions are right, but since the fungus does not thrive on young, green fruits, no serious outbreak need be feared until July. Owing to climatic influence the bitter-rot disease is confined mainly to the southern tier of apple-growing States.

"The second limiting factor, namely, varietal resistance, varies in different sections of the country. For example, the Yellow Newton in Virginia is very susceptible to the disease, and under favorable conditions the entire crop may be destroyed, while the Ben Davis in the same orchard will become only slightly, or not at all, affected. On the other hand, the Ben Davis, in portions of the Middle West—southern Illinois, southern Missouri, and north-western Arkansas—is one of the most susceptible varieties. This would indicate that there are two strains of the fungus, the Ben Davis being susceptible to the one occurring in the West and resistant to the one occurring in Virginia.

"The most susceptible varieties grown in bitter-rot sections are Yellow Newtown, Willow, Huntsman, Smokehouse, Stark, Jonathan, Ben Davis, and many other less prominent varieties." (N. B. In Indiana Grimes Golden is especially susceptible.)

"**TREATMENT:** Although it has been abundantly demonstrated that bitter rot can be readily controlled, even under the most severe conditions, many apple growers look upon it as the most treacherous of all the diseases with which they have to contend. The chief

reason for this is the irregularity with which the disease appears. One year an outbreak may occur in July, while the next year the disease may not appear until September. Varieties partly resistant to the disease may go through several seasons without becoming affected, but when there comes a season unusually favorable to the fungus, much of the fruit of these varieties may be destroyed by the disease. This erratic habit of the disease keeps the apple grower in doubt as to when to expect it and when to spray. He does not care to give his orchard three or four bitter-rot sprayings when there is no bitter rot to fight, and he is loath to begin the treatment in June if the disease does not occur until September, yet the only safe plan in bitter-rot districts is to expect the disease every year and to keep the fruit protected from the latter part of June until the end of September.

"Bordeaux mixture is still the best fungicide to use for bitter rot, the lime-sulphur solution having proved only partially effective against this disease. Fortunately Bordeaux mixture has very little or no injurious effect on the apple after the young fruits have attained an age of six or eight weeks, and may therefore be used for bitter rot with comparative safety.

"As to strength, the mixture should be used as weak as is consistent with good results in order to avoid as much as possible leaving a stain on the ripe fruit. A mixture composed of 3 pounds of bluestone and 4 pounds of lime to each 50 gallons of water, if properly applied, is sufficient for ordinary bitter-rot treatment; but the very susceptible varieties in districts where the disease is common should be sprayed with a stronger mixture, composed of 4 pounds of bluestone and 4 pounds of lime to 50 gallons of water.

"In order to protect the fruit throughout the possible bitter-rot infection period the trees should be sprayed four times at intervals of two to three weeks, beginning seven to eight weeks after the petals have been shed. In the bitter-rot belt the dates of the application would be about as follows, though varying somewhat with the season: (1) June 25-30, (2) July 10-15, (3) July 25-31, and (4) August 10-15. Such a course of treatment, properly carried out, will secure protection against outbreaks of bitter rot under the most adverse conditions. By observing the weather conditions and watching for the first infections the first application may be delayed a few days and the intervals lengthened so that three sprayings can be made to do the work. With very susceptible varieties this is risky, but with varieties only moderately susceptible three sprayings are sufficient.

"The removal of cankered limbs and the destruction of bitter-rot mummies doubtless help to control the disease, and should be practiced, but these precautions can not take the place of spraying.

"For the control of the second brood of the codling moth arsenate of lead at the rate of 2 pounds to each 50 gallons of Bordeaux mixture should be used in the second and third bitter-rot sprayings."

BLACK ROT.

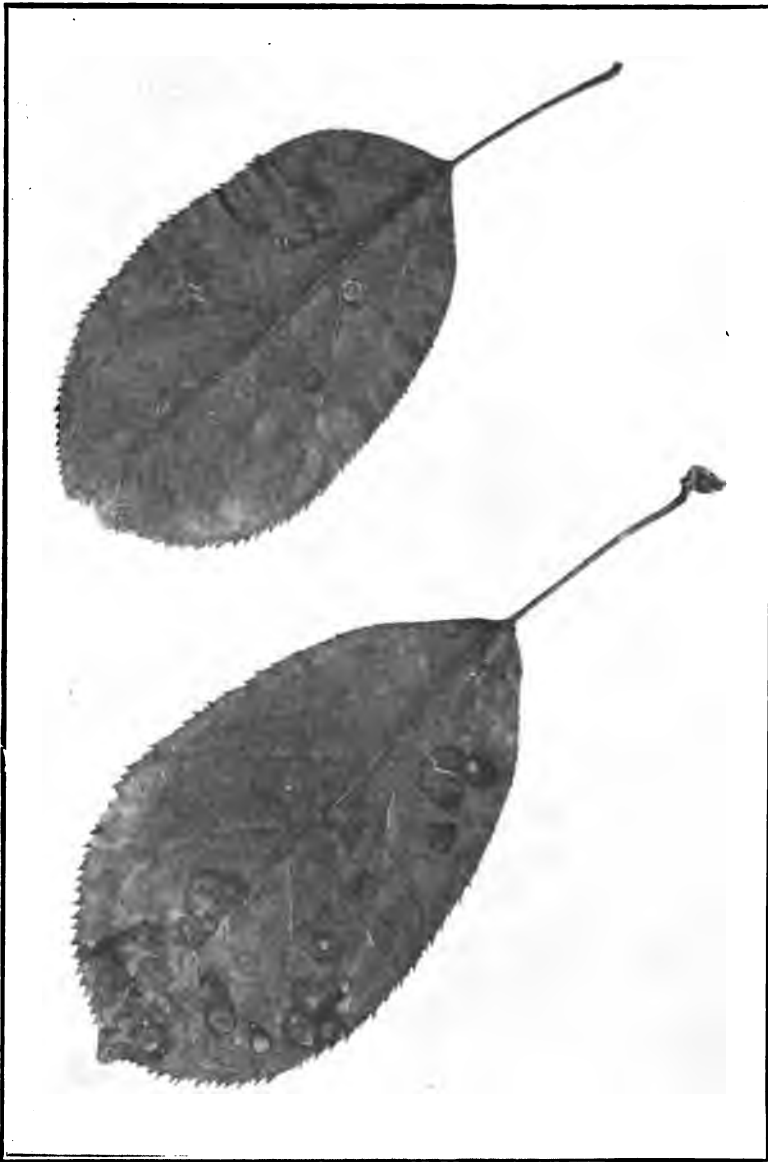
Sphaeropsis Malorum—Pk.

Black rot attacks the apple, pear and quince and has been designated by the following common names: New York Apple Canker, Black-Rot Canker, Apple Leaf Spot, Frog's-eye Leaf Spot, Leaf Spot, Black Rot of the Fruit of Apple, Pear and Quince.



BLACK ROT ON APPLE. (Original.)

The main damage is wrought by the attacks of the fungus on the foliage which very often results in complete defoliation in mid-summer—thus preventing the development of fruit buds for the following year's crop and causing the fruit that may be on the trees to mature poorly. This premature dropping of the foliage is a shock to the tree and in its general weakened condition it is more susceptible to other troubles—a condition indirectly responsible to black rot. Diseased foliage that does not drop prematurely



FROG'EYE OR BLACK-ROT LEAF SPOT ON APPLE. (Original.)



BLACK-ROT APPLE MUMMY. A source of infection.

is more or less functionless as the diseased area is useless to the tree. Black rot may be found anywhere east of the Rocky Mountains.

Spores are carried over winter in the cankered areas on the branches and trunks and to some extent on the diseased leaves that may remain on the tree. These start the disease on the leaves in the spring soon after they are unfolded. It follows, therefore, that an early treatment is essential. The regular spraying for scab with lime-sulphur will effectively control black rot.

The spots on the leaves may be circular—resembling a frog's eye—or may be very irregular in shape. They are bounded by a purplish color, and the entire spot turns gray as it gets old. It is not uncommon to see several spots that have grown in diameter until their borders overlap each other. Although various other fungi have been found associated with the black rot in the leaf spots, yet there has never been conclusive evidence to prove that *Sphaeropsis* is not the primary cause of the trouble.

THE BLISTER CANKER OF THE APPLE OR ILLINOIS CANKER.

Nummularia discreta—Tul.

This canker is readily recognized by the characteristic blister-like areas scattered over the affected part of the trunk or branch. The disease shows itself in its early stages by a brownish sunken area of the bark. Spots of healthy tissue exist within the infested area for a time, but these soon die. Hasselbring describes the appearance of this canker as follows:

“The bark of the older parts becomes much roughened and blackened as if it had been charred. Numerous rifts and cracks appear over the surface of the dead bark which is very dry and brittle, and falls off in irregular patches, exposing the dead wood. The circular stromata are firmly attached to the wood by means of a ring of hard fungous tissue, so that they may remain seated on the wood even after the bark has fallen away. The entire blackened area is dotted over with the circular stromata which form the most pronounced distinguishing feature of this canker. The disease is always easily recognized by the stromata which distinguish it clearly from the New York apple tree canker.”

It is believed that the blister canker is a wound parasite, and this belief is well borne out upon observation of its general prevalence in orchards where careless pruning has been done. Large wounds that are left unpainted or unprotected furnish an ideal place for the entrance of spores of this disease. Several trees have

been observed by the writer during the past season that have died from apparently no other cause, and it is probable that the loss in the State from this disease has been greatly underestimated. It is not at all unusual to find a canker that has started from a large exposed wound to have worked its way entirely around a large



THE BLISTER CANKER OF THE APPLE ON A LIMB. (Original.)

branch or the trunk of the tree. Close watch should be kept and diseased parts cut out and burned as soon as they appear. Properly covering wounds with paint or other wound dressing is necessary to check the spread of this disease.

CROWN GALL OF PLANTS.

The following conclusions relative to crown gall have been arrived at by Dr. Erwin F. Smith, and for those who are in doubt as to whether the welfare of the tree or plant is interfered with by this disease, may arrive at a conclusion from the following résumé of Dr. Smith's investigations. Although parts of the following are somewhat technical, to avoid misconceptions that might result from omitting some of it, it seems advisable to include the entire summary.

***RESUME:** The principal facts brought to light during this study and our earlier studies may be summarized as follows:

(1) Crown galls occur on a great variety of plants, but not always on the crown; any part of the root or shoot is liable to attack.

(2) They are injurious to the plant in varying degrees, depending on the species, on the parts attacked, on the size and vigor of the individual, etc. They are most injurious to young and rapidly growing plants.

(3) Young, well-nourished, rapidly-growing tissues take the disease more readily than old or slow-growing ones.

(4) They are all of parasitic origin, unless the one on the beet, studied by Jensen, Reinelt, and Spisar, in Europe, should prove an exception. We found it difficult to obtain virulent cultures from old galls occurring naturally on the sugar beet, but did finally obtain slow-growing tumors from certain colonies.

(5) The structure of crown gall is unlike that of club-root of cabbage, which is a hypertrophy rather than a hyperplasia.

(6) We have isolated the parasite from 24 species belonging to 14 families of phanerogams. Some species have resisted infection.

(7) These galls are due to schizomycetes, either to one polymorphic species, or to several closely related species. Further studies are necessary. For notes on the morphology and biology of these isolations see Bulletin 213, page 127.

(8) The infectious nature of the organism isolated has been proved by hundreds of inoculations and its ability to produce galls

* Bul. No. 255 Bureau of Plant Industry, U. S. Department of Agriculture.



CROWN GALL ON APPLE NURSERY STOCK. (Second Annual Report.)

on other plants than the one from which it was isolated by many cross inoculations. (Bul. 213, p. 133.)

(9) The parasite has been shown to occur not only in the primary tumor, but also in the secondary tumors and in the connecting tumor strand. Once only in the latter.

(10) Various noninfectious saprophytes also occur in crown galls especially when old, viz., white, green-fluorescent, yellow and pink bacteria; fungi; mites; myxomycetes, etc. Other infectious organisms may also gain entrance, viz., the pear-blight bacillus, the fungi of root rot, and borers which, especially in the peach, seem to prefer the soft tissues of the galls.

(11) The parasite has been grown in pure culture on a variety of media and its morphology and cultural peculiarities determined.

(12) When taken from young agar or bouillon cultures, *Bact. tumefaciens* is a short rod with rounded ends, dividing by fission and motile by means of a polar flagellum (sometimes two or three are present). Short chains and filaments occur. Under unfavorable conditions branched forms (involution bodies) are common. It stains readily, but not by Gram. It is not acid-fast. It is not distinctly capsulate and does not produce spores. For additional details see Bulletin 213.

(13) It grows readily on a variety of the common culture-media but nearly always it is slow to start off when cultured directly from the tumors. It forms small, white, wet-glistening, circular, flat colonies on agar plates and is also white on other media. It does not liquefy gelatin nor are its gelatin colonies characteristic. The organism is aerobic in its tendencies. It forms stringy filamentous growths in bouillon. The coagulation of milk is delayed. It blues litmus milk. It does not reduce nitrates nor grow well in Chon's solution (daisy). It is sensitive to heat, to dry air, to acids, and to germicides. For additional notes see Bulletin 213.

(14) The organism slowly loses virulence when grown on culture-media. We believe that many of the bacteria also lose virulence within the tumor, because not all colonies growing typically on agar poured plates, and in other media, are infectious.

(15) Some of its biochemical properties are now known, to wit, the production from grape sugar of an acid which seems to play an important rôle in the tumor development. Alcohol also occurs.

(16) It has also been stained within the tissues of the tumor and its form and locus therein determined.

(17) The morphology and biological peculiarities of the tumor growth have been studied.

(18) The tissues of the gall multiply excessively and in opposition to the best interests of the plant.

(19) The galled tissue, which is often of a soft, fleshy nature, is much subject to decay. It is not usually corked over, and this absence of a protective surface allows the ready entrance of water and other parasites.

(20) The tumor originates in meristem, usually in the cambium region. It may perish within a few months or continue to grow (parts of it) for years.

(21) The tumor consists, or may consist, not only of parenchyma cells but also of vessels and fibers, i. e., it is provided with a stroma which develops gradually as the tumor grows. A proliferating tumor usually contains not only meristem but pitted vessels and sieve tubes; it may also contain wood fibers, but does not always.

(22) The tumor sends out roots (tumor strands) into the normal tissues. These may extend for some distance from the tumor—how far is not known. These strands consist of meristem capable of originating medullary rays, tracheids, and sieve tubes. In the daisy the strand passes through the protoxylem region of the stem. It is rich in chloroplasts. It usually takes a deeper stain than the surrounding tissues, from which it is sharply delimited. A considerable part of it consists of unripe, actively vegetating cells.

(23) In the daisy the infiltrations are not through the vessels, but between them in a tissue offering little resistance to intrusion, i. e., the region occupied by the thin-walled, delicate spiral vessels.

(24) In the substance of these deep-lying strands secondary tumors develop. These gradually rupture their way to the surface.

(25) The secondary tumors tend to take on the structure of the primary tumor, e. g., if the latter is in the stem and the former in a leaf, the secondary tumor shows a stem structure.

(26) The stimulus to tumor development comes from the presence of the parasite within certain of the cells. Apparently it is not in all. The organism has not been observed with certainty outside of the cells, either in the vessels or the intercellular spaces, nor is it abundant in the cells. Usually copious inoculations have to be made to insure cultures.

(27) Under the microscope it can not be made out in unstained sections with any certainty, and most bacterial stains also

fail to differentiate it in the tissues. It is best observed in tissues impregnated with chloride of gold.

(28) When subjected to unfavorable conditions in cultures the parasite develops involution forms consisting of club-shaped, Y-shaped, and variously branched bodies. The same bodies occur within the cells of the tumor, making it reasonable to infer that the parasite is there exposed to similar unfavorable conditions.

(29) These involution forms may be produced at will by the addition of dilute acid to young cultures. The abnormal forms (Y-s, etc.) thus produced either refuse to grow when sown in agar plates or develop colonies slowly. The same results are obtained very often on making poured plates from the tumors, viz., either no colonies appear or slowly developing ones, but subcultures from these slowly developing colonies grow promptly. Sometimes also from the tumor one gets the organism promptly on agar poured plates (third day). In the delayed cases the mere change from tumor tissue to culture media is not the cause of the delay.

(30) By repeated inoculations through a series of years we obtained (Bul. 213, p. 177) plants which appeared to be more resistant to the disease than check plants, but by subsequent inoculations on descendants of these plants we obtained numerous well-developed primary and secondary tumors, so that the resistance which we obtained must be regarded either (a) as of a fugitive nature, or (b) as of a low grade easily overcome by a more virulent strain of the parasite. That the cultures used for these subsequent inoculations came from a more virulent strain may be assumed, we think, both because they were plated from a tumor which appeared on one of our most resistant plants, and because the cultures tried on a great number of plants (including those described in this bulletin) produced primary tumors very quickly and showed an unusually strong tendency to develop secondary tumors.

(31) The relation between the host and the parasite may be regarded as a symbiosis in which the parasite has the advantage.

(32) The bacterium is a soil organism and planters should aim to keep their lands free from it by refusing to plant infected stock.

(33) Nurserymen should plant on uninfected land and carefully avoid heeling good stock into soil which has previously received infected plants. Nurserymen have been largely responsible for the dissemination of this disease.

(34) The organism is a wound parasite. Its entrance is favored by careless grafting (Hedgcock) and by the presence of borers, nematodes, etc.



CROWN GALL. Root and aerial forms on raspberry. (Original.)

(35) These galls occur on the roots of legumes and have been mistaken for the nitrogen root nodules.

(36) The development of this disease is regarded as closely paralleling what takes place in cancer of men and animals.

(37) There are no true metastases in crown gall, but this does not to our mind, militate against the comparison, for whether a cancer shall be propagated by floating islands of tissue, or only by tumor-strands, appears to be a secondary matter depending on the character of the host tissues rather than on the nature of the disease. The essential element is the internal stimulus to cell division.

(38) Nothing in this bulletin should be construed as indicating that we think the organism causing crown galls is able also to cause human cancer, but only that we believe the latter due to a cell parasite of some sort, and offer the preceding pages in support of this contention.

CEDAR RUST.

Gymnosporangium juniperi-virginianæ—Schw.

Cedar rust has also been known as Orange Rust and attacks the apple, pear, quince and other pomaceous plants.

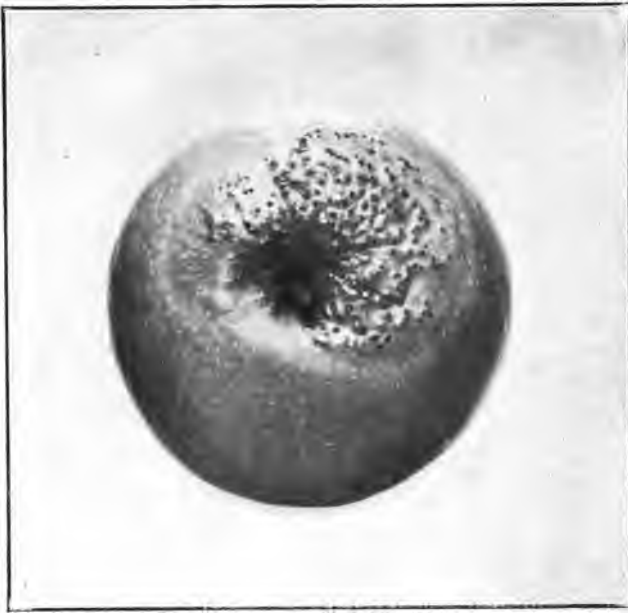
The disease is very common east of the Rocky Mountains where the red cedar (*Juniperus virginiana*) exists. It is only occasionally



THE AECIDIAL STAGE OF CEDAR RUST ON HAW LEAVES. (Second Annual Report.)

that bad outbreaks occur, but in southern Indiana, where so many red cedars are found, it is to some extent found every year, and it is not at all unusual to find orchards completely defoliated by it.

The fungus attacks the foliage and fruit of the hosts mentioned above. The injury shows itself at first as small yellow spots which often grow to be $\frac{1}{4}$ inch in diameter. The tissue of the leaf becomes swollen on the under side forming a blister-like structure upon which cup-shaped spore receptacles are produced. When the fruit is attacked the spore receptacles are also produced. Diseased fruit is often disfigured as the infested area reaches considerable size. The market value of such fruit is greatly depreciated as all specimens attacked by cedar rust are excluded from first class fruit.



CEDAR APPLE RUST ON GRIMES GOLDEN APPLE. (Original.)

There are various species of rust that require both the red cedar and pomaceous plants as hosts.

The spores are produced on the diseased leaves and fruit and are carried by the wind to red cedar trees. These spores germinating upon the twigs of the red cedars produce the characteristic "cedar apples" which are globular in shape and are from $\frac{1}{4}$ to 1 inch in diameter. Red cedars that are infected in late summer or fall produce cedar apples the following spring which develop during the growing season and the second spring following the infection of the cedar, spores which develop on the cedar apples are



CEDAR APPLE ON RED CEDAR. (Third Annual Report.)

carried by the wind to the apple, pear, quince, etc., causing the characteristic injury. Long, yellow, gelatinous tentacles develop on the cedar apple and spores are produced within these gelatinous masses and after the cedar apples dry out the spores become like minute grains of dust and are carried long distances by the wind. Those that lodge on the foliage of pomaceous plants germinate by producing a thread-like structure that enters the tissue. Spores of a different nature that will not reinfect the apple are produced on these hosts. It therefore follows that both the red cedar and the pomaceous hosts are essential for the existence of this fungus.

Plenty of moisture is needed to produce the spores on the cedar and moisture is also favorable for their growth on the apple. A serious outbreak, therefore, may be expected when wet periods alternate with dry ones, allowing the spores both to be produced and carried by the wind. The infection period begins about the time of blooming and lasts from three to six weeks, depending upon climatic conditions.

TREATMENT: All red cedars should be destroyed within a radius of at least a mile. This is particularly true of those in the direction from which the prevailing winds blow. Both small and large cedars should be destroyed as the young trees produce the "apples" the same as the larger ones. The ordinary spraying applications for the control of leaf spot and scab will hold this disease in check, but no method of combating it is more satisfactory than that of destroying red cedars in the community.

SOOTY FUNGUS AND FLY SPECK.

Leptothyrium Pomi—(Mont. and Fr.) Sacc.

This disease shows itself late in the season and is especially abundant if the season is unusually moist or the orchard is in a low, damp situation. Apples on the lower limbs that are more or less shaded suffer most. The fruit is not injured beneath the skin and the only loss is due to the unsightly appearance of the disease on the fruit, thus depreciating its market value.

Since the fungus is entirely on the surface it is comparatively easy to control. Where bitter rot is sprayed for no further consideration need be taken of sooty blotch and fly speck fungus as an application of Bordeaux in July will be effective. Lime-sulphur or weak Bordeaux mixture will control the disease and if no treatment for bitter rot is necessary one may use whichever fungicide he finds advantageous.

It is often supposed that fly speck and sooty blotch are two distinct diseases, but according to Duggar, they are different aspects of the same trouble.



SOOTY FUNGUS ON APPLE. (Original.)

BALDWIN FRUIT SPOT.

Cylindrosporium Pomi—Brooks.

This disease affects many varieties of apples, but on account of the Baldwin being particularly subject to its attacks, it has been commonly termed "Baldwin Fruit Spot." The disease appears in July or early August and shows itself on the colored surface of the apple in spots of a deeper red color than the fruit and on the green parts the affected spot becomes a deeper green. As the disease advances the spots become sunken slightly and on the red varieties they turn black or brown, the tissues beneath the spot becoming corky. These spots develop to a considerable extent after the fruit is stored, but according to Brooks, cold storage checks their spread. Spraying readily controls this disease. Either the use of lime-sulphur as recommended in the spray calendar for summer sprays or a weak solution of Bordeaux will give good results. When Bordeaux is applied for apple blotch or bitter rot the Baldwin Fruit Spot should be controlled incidentally.



THE BALDWIN FRUIT SPOT.

FRUIT PIT.

This trouble is often confused with the preceding disease, but may be distinguished by the following characteristics. In its early stages this spot shows no difference in color on the skin of the fruit and causes a slight depression. Small pits appear as bruises and look very much as if hail had hit the apple. Soon they become very noticeable as the area of an individual pit has grown to be about $\frac{1}{4}$ inch in diameter, and becomes decidedly sunken. These enlarged spots are more highly colored than the surface of the surrounding skin and finally take on a brownish color. In later stages of the trouble, spots of brown tissue of bitter taste may be found beneath the affected areas.

Some Diseases of the Pear and Quince.

(For diseases not mentioned here, see "Apple Diseases.")

PEAR OR FIRE BLIGHT OF THE APPLE, PEAR AND QUINCE.

Bacillus amylovorus—(Burrill) De Toni.

This disease like crown gall is of bacterial origin. It has been known for over 100 years and has been designated by such names as Fire Blight, Twig Blight, Blossom Blight, Pear Blight, etc. It is



PEAR BLIGHT. Diseased twig and leaves; healthy twig above. (Third Annual Report.)



A PEAR-BLIGHT CANKER. (Third Annual Report.)

a native disease and is supposed to have originated in the East on wild crab or thorn trees. It attacks apple, pear, quince and many native pomaceous plants. Such varieties as the Bartlett, LeConte and Seckel are very susceptible to it, while the Winter Nelis, Duchess and Kiefer are among the most resistant. It seems to show no preference to varieties of the apple. The disease shows itself in the spring at blooming time and the part of the host that is affected wilts and begins to blacken and finally becomes quite black. The fact that the tips of the flowers show infection first indicates that the chief cause of the spread of the disease is insects, especially bees. The nectary of the flower furnishes an ideal medium for the multiplication of the bacteria and from this they work down through the twigs. The disease sometimes starts in the sappy water sprouts or twigs which are inoculated with the germ by biting or piercing insects. The germs cannot gain entrance to the host on healthy tissue unless an injury of some sort is produced. The bacteria winter over in blighted twigs that are subject to a proper supply of moisture and are protected from thoroughly drying out. From a very few twigs, however, the disease may be spread very extensively during the blossoming period. Intense cold does not affect the germ, but proper moisture conditions are necessary.

Whole branches may be killed by this disease and it may also enter the body of the tree. Occasionally it spreads only a few inches from the tip. This is especially true of the apple. At the time the disease is working down the twigs it is not possible to determine the limit of infection as germs may exist several inches or a foot below where it shows itself on the exterior. After it has ceased to spread, however, its limits are readily designated by the blackened and shriveled appearance of the dead part.

CONTROL: The control measures that have been practiced in the past seem to be the most practical at the present time. All blighted parts of the tree should be cut out and burned, and if this is done during the season that the disease is spreading the cuts should be made a considerable distance from the affected part. The pruning tools should be disinfected after each cut with bichloride of mercury (corrosive sublimate) solution 1 to 1,000 strength. Each exposed wound should also be disinfected with this solution. When the exposed stubs cannot be reached from the ground a pole with a sponge or swab attached to the end may be used for applying the disinfectant. If long-handled pruning



QUINCE LEAF AND FRUIT INJURED BY THE PEAR AND QUINCE LEAF-BLIGHT FUNGUS. (Second Annual Report.)

shears are used the sponge may be wired near the end. It may be saturated with the disinfectant at the same time the shears are dipped into the solution.

LEAF BLIGHT OF PEAR AND QUINCE.

Entomosporium maculatum—Lév.

The spots of this disease occur on the upper side of the leaves and are at first small with reddish-colored centers and dark borders. When the disease becomes severe the leaves turn brown and fall prematurely. This fungus is often confused with the leaf spot on the pear but may be designated from the latter by the fact that pear leaf spot produces a larger spot on the leaf that is not so highly colored, is not so nearly circular, and is not so distinctly marked off from the healthy tissue of the leaf. Pear and quince leaf blight not only affects the leaves, but shows itself upon the fruit as small red spots which later turn dark, producing a rigid surface and cracking open in the center as in a bad case of scab. A few varieties such as the Duchess and Keifer, seem to be more or less resistant to this trouble. The susceptibility of varieties in general, however, seems to differ with the locality. The disease often causes damage on the nursery seedlings by producing early maturity thus making budding difficult. Spores of pear and quince leaf spot are carried over winter on infested leaves. Leaves that are diseased early in the season produce the spores from which the fungus spreads during the summer. Spraying with Bordeaux mixture or lime-sulphur at the times recommended for the control of apple scab will be effective.

Some Diseases of Stone Fruits.

BROWN ROT OF STONE FRUITS.

Sclerotinia fructigena—(Pers) Schroet.

This disease has been known for perhaps sixty years, and causes greater loss to stone fruits than any other single trouble.

This disease is especially bad when the weather is muggy at or near the ripening period of the fruit. The disease spreads very rapidly under conditions of this sort. Practically no variety of peach, plum or cherry is exempt from the attacks of this disease, but it has been observed that such varieties as Hill's Chili, Alexander and Triumph do not suffer so much—probably on ac-



BROWN-ROT MUMMIES IN WINTER. (Second Annual Report.)

count of their being so heavily covered with minute hairs or fuzz. It is not usual for brown rot to do damage before the fruit is half grown; but under especially favorable conditions it will cause great losses even in the blossom. During the past season a great deal of damage from this disease showed itself while cherries and plums were in bloom. In every instance observed, however, there were plenty of mummied fruits remaining on the tree. It is of prime importance in the control of brown rot that this infected fruit be cleaned from the trees and not allowed to carry the spores over winter to cause an outbreak of the disease the following season. The young, rapidly growing twigs may also become infected—probably from decaying flowers or fruit on the same twigs.

The disease first shows itself by a small dark-colored decayed spot. This grows in size until the whole fruit is involved. The fruit retains its shape and does not usually show signs of shrinking and drying up until the rot has almost or entirely taken in the whole fruit.

It is not difficult to recognize the fungus in its later stages by the so-called mold tufts which are grayish in color. The characteristic brown color together with its well-known hosts leave no doubt as to the trouble whenever it is seen.

REMEDIES: As the spores pass the winter on mummied fruit, it is evident that an important step to take would be to remove this source of trouble. If fruit has been allowed to decay on the tree or on nearby trees the bud scales and bark are undoubtedly infested with spores that will begin to grow as soon as conditions are favorable. Spores may also be blown from long distances. Thus a dormant spraying with lime-sulphur (1 to 8) or strong Bordeaux (6-6-50) would be effective. Summer spraying with self-boiled lime-sulphur or commercial lime-sulphur will very effectively control the brown rot of stone fruits.

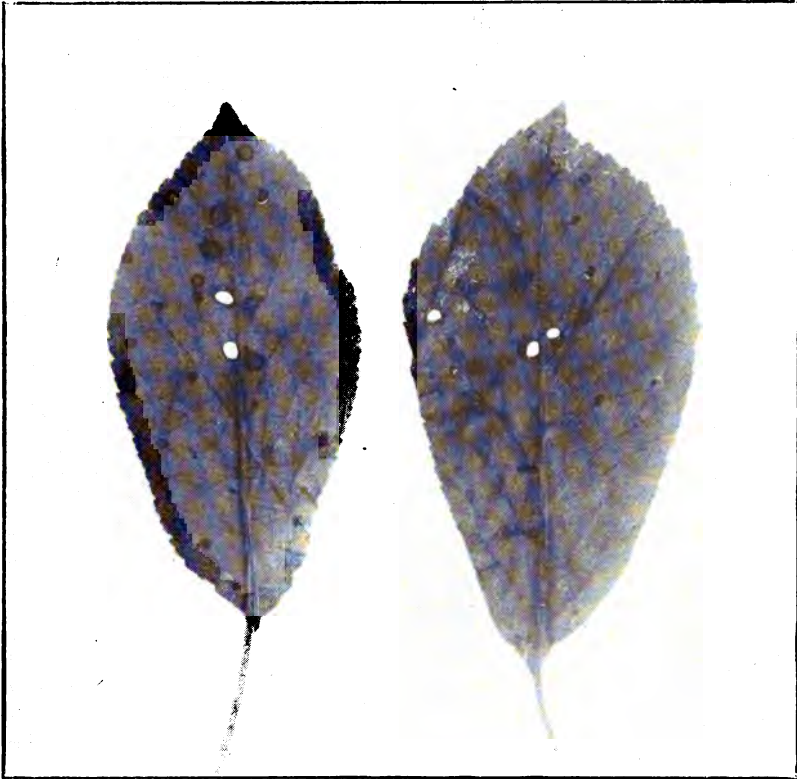
LEAF SPOT OF CHERRY AND PLUM.

Cylindrosporium Padi—Karst.

The "shot-hole" trouble so often found in cherries and plums may be caused by a number of different fungi. The holes in the leaves are caused by the diseased part of the leaf breaking away from the healthy tissue and falling out. The disease that caused the almost universal defoliation of unsprayed cherry trees through-

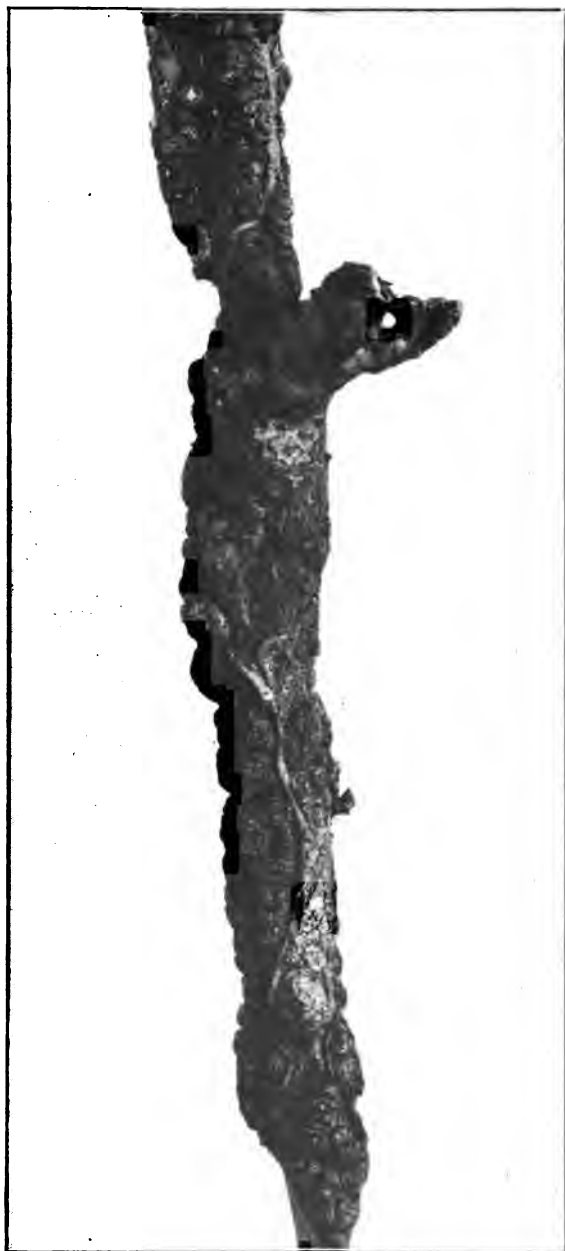
out the State during the past summer was *Cylindrosporium Padi*, commonly designated as "yellow leaf," "shot-hole fungus" or "shot-hole." In many instances the leaves were practically all off the trees early in July. It is supposed that the turning yellow of the foliage early in the season is incidental to an infestation of this disease. The Americana varieties of plums show the greatest resistance, while the Japanese varieties are especially susceptible.

Spore-bearing structures have been found on cherry twigs and



SHOT-HOLE FUNGUS ON CHERRY LEAVES. (Original.)

it is quite probable that these are a source of infection in early spring. Diseased leaves that have fallen should be destroyed or plowed under and an application of strong Bordeaux in very early spring, before the buds open, or a dormant spray with lime-sulphur, together with the regular brown-rot sprays should control this trouble.



BLACK KNOT ON PLUM. (Original.)

BLACK KNOT OF PLUM AND CHERRY.

Plowrightia morbosa—(Schw) Sacc.

This trouble is very common all over the country on plums and cherries, but in Indiana for some reason it shows a decided preference to the plums. Its spread over the country started in the East and at the present time is pretty thoroughly established from the Atlantic to the Pacific. There are, however, extensive areas in the Southwest and smaller areas in the central West where the disease has not become well established. The native varieties of plum suffer worst, and but few varieties are free from it. Both wild and cultivated plums and cherries are subject to its attacks.

The knot is very conspicuous on the twigs and limbs and its common name expresses very well its appearance. It may extend from one to several inches along the branch or twig and occasionally entirely girdle a branch, resulting in the death of the latter. It, however, is more often confined to one side of the branch. The growth usually begins in the spring and becomes full grown in mid-summer. When small branches are infested they become curved considerably on account of the increased growth on the side where the knot exists.

The diseased tissue is made up partially of the fungus itself and partially of the tissue of the host. This intermingling of the disease and host tissues is caused by the destruction of the cambium of the host. Small greenish spots may be seen on the surface of the knot in the spring and later in the season a light brown or pinkish velvety surface appears. The spread of the disease takes place at this time. The perfect stage of the fungus is developed during the winter. All knots should be cut out and burned in early spring, before the spores are disseminated. Pruning out, in time will be effective. All infested wild cherries and plums in the vicinity should be destroyed. Instances are on record where large infested areas have been absolutely cleaned out merely by cutting out and burning the knots.

Some Diseases of Grapes.

BLACK ROT OF GRAPES.

Guignardia Bidwellii—(Ell.) Viala & Ravaz.

This is the most destructive and most widely distributed disease of the grape east of the Rocky Mountains. The young and tender parts of the plants furnish a place for the spores to grow which

are carried by the wind and rain. The disease on the leaves and shoots causes reddish-brown spots to appear. These spots are clearly marked off from the healthy tissue and are circular with black centers. The spores spread from these diseased shoots to the



BLACK ROT, SHOWING SPOTS ON LEAVES. (Third Annual Report.)

berries and therefore the treatment should be applied to the winter spores, thus avoiding infection of the leaves and shoots in the spring.

The berries are attacked when they are about one-half to two-thirds grown. A reddish-brown to black spot appears at first on the berry and then spreads until the whole berry is involved. The

infected fruit turns black and becomes shriveled. Small spores develop on these mummied berries, causing a further infection during the growing season. Diseased fruit, especially that which remains on the vines furnishes a place for the resting or winter spores to develop.



THE BLACK ROT OF GRAPE. Showing damage to fruit. (Third Annual Report.)

In small vineyards sacking the grapes is practicable and will shield the fruit from black rot. In larger areas, however, spraying for this disease becomes necessary. Applications should begin in early spring with the use of strong Bordeaux mixture (6-6-50) just before the leaf buds begin to open. The next treatment should take place as soon as the leaves are out, using a weakened solution of Bordeaux mixture (4-4-50). For this spraying arsenate of lead should be added as in the case of all subsequent applications. The time for the following sprays should be regulated by the weather conditions, as hot, wet weather is very favorable for the spread of this disease. Ordinarily three or four more applications about two weeks apart will be sufficient for an effective control.

DOWNY MILDEW.

Plasmopara Viticola—(B. and C.) Berl. and DeToni.

When conditions are ideal for its development, downy mildew is among the most destructive diseases of the grape. It attacks the

foliage, causing yellowish-green spots with irregular margins on the upper surface of the leaves. As the season advances these spots turn brown. On the under side of the leaves is found a white downy growth from which the fungus gets its common name. Summer spores are produced on this growth and are carried by wind and water to the fruit and other parts of the plant. The young fruit is attacked and a downy growth appears similar to that on the under side of the leaves. This condition on the fruit is commonly termed "Gray Rot." If the berries are one-half grown when attacked they show a brown or purplish spot which spreads over the entire berry. The fruit becomes soft and wrinkled and usually drops when the vines are jarred. The winter or resting spores develop in the diseased parts of the plant. From these sources reinfection occurs the following spring.

All diseased parts of the plant should be destroyed as they occur, and spraying operations as recommended for the control of black rot of grape should be followed.

POWDERY MILDEW.

Uncinula necator—(Schw.) Burr.

Powdery mildew does not usually become serious on American varieties, but is very destructive on the European or *vinifera* type. Powdery mildew differs materially from the downy mildew in the nature of its growth as it belongs to a different group of fungi and its growth is on the surface of the plant. It obtains its food from the host by a sucker-like structure which penetrates the exterior layer of cells. The summer spores develop on filaments of external growth on the upper surfaces of the leaves. It is myriads of these filaments that gives the leaves the characteristic light-colored mealy appearance. In severe attacks of this disease the leaves turn brown and fall prematurely. The young shoots are affected the same as the leaves. On the fruit the fungus causes a grayish color with brown specks, and the berries do not ripen. The berries often burst open on one side, exposing the seeds.

Resting spores that carry the disease over the winter are developed late in the season. Quite contrary to the rule dry and hot weather is favorable for the development and spread of this disease. Control methods as recommended for the control of black rot will incidentally control powdery mildew.

ANTHRACNOSE OF GRAPE.

Glocosporium ampelophagum—Sacc.

Anthrachnose of grape is commonly called Bird's-Eye Disease on account of the characteristic spot that it produces on the fruit resembling a bird's eye. The disease is very well distributed over America and Europe and becomes especially serious at times in



GRAPE ANTHRACNOSE. (Third Annual Report.)

some localities, occurring as an epidemic upon the shoots, leaves and berries. It is more common, however, on the shoots and leaves. 'On the berries where the "bird's-eye" effect is produced the spots are at first a grayish-brown; but as they grow the center becomes sunken and reddish-colored bands may be seen near the boundary of the affected parts. The berries sometimes become wholly involved by the growth of the spots. The diseased areas on the shoots are elongated instead of circular as on the fruit.

In controlling this trouble all diseased canes should be cut out and destroyed as soon as they are discovered. Spraying as



ANTHRACNOSE OF RASPBERRY AND BLACKBERRY.

in the control of black rot, using the same material, will give excellent results. The fact must not be ignored, however, that pruning out the affected parts on the vine is essential.

ANTHRACNOSE OF RASPBERRY AND BLACKBERRY.

Gloeosporium Venetum—Speg.

Raspberries are usually more seriously affected by this disease than blackberries. The spots on the canes are first small and purplish but later turn gray and become sunken. It is not unusual to find raspberries so severely infested with anthracnose that the whole cane will have a general scabby appearance. Very small spots may occur on the foliage, but this part of the plant is not usually damaged by the disease. Anthracnose is best controlled by setting plants free from infestation, or from uninfested patches and in localities where none of its hosts have been recently grown. Canes showing the disease should be cut out and burned as soon as discovered.

Proper rotation and cutting out infected canes as they appear seem to be the most effective ways of handling this trouble. Good results, however, have been reported from spraying with strong Bordeaux mixture immediately preceding the opening of the leaves. For best results one should combine all of the above control methods.

ORANGE RUST OF RASPBERRY AND BLACKBERRY.

Gymnoconia Peckiana—(Howe) Tranz.

The usual hosts of this disease are the black raspberry and blackberry. The fungus appears early in the spring but is not conspicuous at this early stage. The affected plants, however, show a poor growth and are spindling and will eventually die. The spores are developed beneath the epidermis of the under side of the leaf and when the skin breaks it shows myriads of bright orange-colored spores. It is these spores that spread the disease. They germinate immediately upon contact with any other host. All infested plants should be dug out and burned as soon as they are discovered.

CROWN GALL.

(See apple diseases.)

SHADE TREE TROUBLES.

The shade tree problem in cities and towns has within recent years become a question of considerable interest. On account of the great number of inquiries received by this office relative to shade tree troubles both in Indianapolis and other cities of the State, it seems appropriate to mention at this time some of the more common troubles to which ornamental trees are subject. Increasing trouble with shade trees within comparatively recent years may largely be attributed to the following causes: Many new varieties of trees and shrubs that are not adapted to our soil and climate have been planted, and new and unnatural conditions for our native trees cause poor growth and as a consequence the tree is made more susceptible to disease and insect troubles. It has also been estimated that at least 50 per cent. of our harmful insects and fungous diseases are of foreign origin, and it has been within comparatively recent years that many have reached Indiana.

It is difficult to estimate the value of a large shade tree conveniently located, as its real worth is calculated differently than one would estimate the value of the same tree standing in the forest. It is, therefore, a good investment to spend considerable time and money to save such a tree from the ravages of insect pests and diseases.

It is true, however, that comparatively large trees can be successfully moved and transplanted with our modern methods of doing this kind of work; but in any case several years of growth are required before a large graceful tree will be produced.

Root suffocation is one of the very common troubles with city trees. Mr. Metcalf, of the United States Bureau of Plant Industry, describes this trouble very well: "Trees differ greatly in their ability to withstand inadequate soil aëration, and this must be taken into account in selecting trees for city planting. What limited space is allowed each individual tree must not become hard, baked or trodden down; it may be in sod or it can be spaded up to a depth of 6 to 10 inches each year, which will usually relieve the situation. In European cities it is the custom to cover the ground about a street tree with a metal grating or "grill" which allows free access of air and protects the soil from being trodden hard. Such grills could be regularly used to advantage whenever the soil

about the tree is limited in surface area and liable to be trodden hard. Aggravated cases of root asphyxiation are likely to occur in places where the ground water is very near the surface, as the water excludes the air. When a period of heavy rains, producing such a condition, is succeeded by drought, many trees succumb. The tulip tree and the beech, both beautiful park trees, are particularly sensitive in this regard and generally fail as street trees in consequence.

"Young trees set too deep are often killed, while it is a familiar fact that covering the earth about trees with soil a foot or more deep usually results in injury, if not death, from the same cause. In grading this is often unavoidable."

There is a general supposition that shade trees are able to obtain sufficient plant food under almost any condition. As a result trees often suffer on account of the lack of nourishment. In the forest there is an annual deposit of leaves which forms a mulch and keeps the ground in good condition. Under city conditions, the leaves are cleared away from beneath the trees and the soil is not usually replenished with anything to take their place. The surface of the soil, therefore, becomes dried out and the root hairs near the surface of the ground where a considerable supply of plant food should be obtained are killed. To alleviate conditions of this sort there is nothing better than well-rotted stable manure; but on account of its odor and unsightly appearance some commercial fertilizer should be used in cities and towns and applied in the spring as the buds are opening. Success has been attained with the use of the following commercial mixture: One part of muriate of potash, one part of acid phosphate, three parts cotton-seed meal, one-half part nitrate of soda. This should be sown broadcast beneath the trees.

Symptoms of starvation are very evident in many parts of Indianapolis and other cities throughout the State. Trees that grow to a large size under normal forest conditions will often be observed to die after the underbrush and leaf mulch has been removed. When large trees grow close to smaller ones they are often fatal to the latter by depriving them of their food supply. This condition may be remedied by digging a ditch between the two trees and cutting off the roots of the large tree which is draining the food supply of the smaller.

It frequently happens in cities that trees die suddenly from no apparent cause. In a case of this sort one should immediately in-

investigate the location of the gas mains and pipes and learn if there is a leak by which the gas could find its way to the roots of the tree. In instances of this kind the foliage usually turns yellow and wilts and to some extent drops. During the growing season this trouble can usually be diagnosed by the characteristic odor of the sap-wood. The only method of handling a case of gas poisoning is to shut off the leak as soon as possible and dig up the ground about the tree to allow the gas to escape.

During the dry season a great amount of artificial watering is necessary. It is necessary especially where sod exists beneath the trees. The natural conditions of the tree with a mulch covering the roots would not require watering except during very severe drought. During the past summer a great many maple trees were affected with what seemed to be disease of the leaves. The tips and edges of the leaf would die and the trees to some extent became defoliated. On account of the abundance of rain a simple drying out condition cannot be the cause of the trouble and up to this time we have not been able to discover any disease. It is probable that some peculiarity in the weather conditions has produced a physiological disorder in the trees, causing the trouble. Trees also suffer from lack of moisture during long periods of severe cold in the winter. When all the moisture surrounding the roots becomes frozen, evaporation is continually taking place and the soil may become actually dried out as a result of continued freezing weather.

A condition called "sun scald" is produced during the winter and is especially destructive to smooth barked trees such as the soft maple. Sun scald injury shows itself on the southwest side of the trees where the greatest heat from the winter's sun is obtained. The cells of the cambium layer begin activities on the southwest side of the trunk and larger branches and this, followed by a sudden drop in temperature, breaks down the cells and the following summer the bark cracks loose and decay enters. This condition furnishes a favorable entrance for insects and is well illustrated by the maple borer.

Trees transplanted from the nursery row or forest, where they have been somewhat protected on the southwest side from the direct rays of the sun, are most seriously injured. Wrapping with burlap or paper for a few years or shading the trunks on the southwest side with a board will obviate sun-scald injury.

Anyone who has had occasion to observe the shade-tree condi-

tions in the smoky section of the cities has noticed the great difficulty in keeping them alive. All trees are injured more or less by smoke and gas, but evergreens suffer most severely, due to the fact that their leaves remain on the trees for a longer time and the injury takes place all the year round. Most of the deciduous trees show a greater tolerance of city conditions than others and this fact should be kept in mind by those transplanting trees under such adverse conditions. The Ailanthus and Sycamore show a greater tolerance to city conditions than the other common shade trees—more especially the former.

Fungous trouble in shade trees may be divided into two groups, viz., wood-rotting fungi and the leaf diseases. The latter can nearly always be controlled by spraying. When any leaf trouble becomes severe enough to cause the leaves to drop, or when a large portion of the leaf surface becomes diseased and functionless, the growth will be stunted and the health of the tree impaired. This weakened condition continued year after year soon results fatally.

Since wood-rotting fungi cannot get into a perfectly sound and healthy tree, it is evident that great care should be exercised in the treatment of wounds caused by pruning or in any other way. The average citizen is not so much concerned about the particular parasite that produces the decay, but he easily recognizes the trouble as "rot" and should take immediate steps to remedy the trouble. In the following discussion on tree surgery by Mr. Swallow, a deputy of this office, he explains in some detail the principal operations in performing this work.

TREE SURGERY.

The many insects that are attacking the bodies of our shade and fruit trees, always ready to take advantage of the least opportunity for doing injury, and the different fungi that are to be found wherever moisture gains an entrance, make some procedure necessary to forestall them in their work.

We find a remedy for these troubles in what is generally known as tree surgery; but what might more truly be called tree dentistry.

This work requires thorough and conscientious operations if it is to be a benefit rather than an injury to the tree. Bad work will result in the loosening of the filling and the enlargement of the cavity by increased decay which goes on behind the cement, all

unknown to the owner, doing more damage than if left open to the air.

The cement filling takes the place of the solid wood as a support, entering the openings and crevices and keeping out moisture, decay and insects. The cement is easily applied and forms a



A TYPE OF CAVITY THAT NEEDS FILLING. (Original.)

substitute for the wood that has been lost through one cause or another. It also furnishes a good base for the healing process which will take place in the cambium layer and finally cover the filling.

The first and all-important thing to remember about this work is that *all* the dead and decaying wood must be removed and that the cavity must be clean and dry. This work is best done with a



• IMPROPER CAVITY WORK. (Original.)

mallet, gouge and chisel, except in the case of a large opening where a small hatchet may be used to advantage, all refuse being removed through as small an opening as possible. Take care not to notch the edges of the aperture by careless use of the tools.

After all the decayed wood is taken out, a shoulder or retention must be made as follows: In the top of the cavity put a shoulder

that is wide and that slopes up and out. This is really a small cavity itself and keeps the filling from slumping and bulging out at the upper end. When making the retention on the sides be sure that they are at least one-half an inch in depth and that the edges of the opening come to the thinnest possible point so that no ridge will be left when the filling is put in. Make the bottom of the



SOME COMMON EXAMPLES OF POOR CAVITY WORK. (Original.)

cavity slope up and back and put in a wide retention on the lower side. If this plan is followed the cement will stick and harden without slumping, as the upsloping bottom acts as a drain for any excessive moisture that may gather at the base of the filling. When the inside is well cleared of all rotten wood and foreign matter it should be washed thoroughly with bichloride of mercury, diluted 1-700 or 1-1,000, and when dry painted with tar, creosote or white lead. Tar and creosote have given good results on large trees, as they are very persistent and will sink in and prevent the action of any fungus that may be left, but they must *not* be put on the bark or the exposed living tissue. Use a good quality of white lead that will not blister and peel off on the smaller trees.

Now cut back the bark on the edges for about one-half inch to make the callous start anew and grow over instead of under the filling.

The filling is composed of sharp sand and Portland cement in the proportion of one of cement to four of sand. Mix this mass well while dry and then mix just enough water to show on top



CAVITY BEFORE WORK IS BEGUN. (Original.)

when rubbed gently with a trowel. The material is then ready for application to the prepared cavity.

If the filling be a large one a guard of burlap, tin or canvas can be used over the front of the cavity to hold the cement in place while it is being tamped hard and until it sets.



REMOVING DECAYED WOOD. (Original.)

In a long cavity it is necessary to make joints so that as the tree sways in the wind the joints furnish flexibility, thus avoiding cracking the filling. A joint is simply a break in the cement that is filled with tarred paper or prepared roofing paper. In building the filling it is best to make it in sections and to insert the tarred paper every 18 inches, i. e., at the top of each section.



CAVITY READY FOR FILLING. (Original.)

When the filling is fairly hard the outside should be chipped off and a mixture of equal parts of sand and cement put on to make a smooth and water-tight face. The outer edges of the filling must come just inside of the edges of the cavity, the filling being a



FIRST SECTION OF FILLING IN PLACE. (Original.)

little higher in the center than on the sides. After the cement is all in place it must be cut back to the paper at the place where the latter has been inserted and the face beveled back to make a smooth crack.

Sometimes a trunk cavity will occur in connection with collar rot. In this case remove all the dirt from about the roots and take



THE FILLING COMPLETED. (Original.)

out all the bad wood. If nothing but a shell is left, as sometimes happens, and the tree seems weak and in danger of blowing over, put a $\frac{3}{4}$ -inch iron rod with a head on one end and a nut on the other, to prevent slipping sidewise, through the tree in a horizontal position about three-fourths of the way up the cavity. To this attach another longer rod within the cavity running parallel with the tree trunk and extending to the hole left by the removal of the earth. Anchor the lower end of this rod firmly, build the filling up as any other and return the dirt to its original position.

Although success is sometimes attained without sterilization it is bad practice to omit it. A sterilizing solution is easily made and readily applied and its use makes sure what is otherwise uncertain. Where the rot is being produced by an active parasite sterilization is absolutely necessary. Where the mycelium producing the disease is not all taken out or reached by the antiseptic, the rot may continue under the paint and cement, resulting in the entire failure of the object in view.

Much cavity work has been done that is far from satisfactory. This poor work has done more damage than is at first realized, as many people will judge the virtues of the work as a whole by the miserable jobs that are brought to their notice. However, if the following rudimentary principles are adhered to, good results are practically certain. (1) Clean cavity from all decayed wood and foreign matter. (2) Have good retention shoulders. (3) Thoroughly disinfect exposed tissue and paint it well. (4) Do not use too much water in mixing cement. (5) Make joints where cavity is three feet or more in length. (6) Cut back the bark on the edges of the cavity so that the new growth will grow properly over the filling. (7) Make union of cement and edge of cavity perfect to prevent the entrance of water.

REPORT OF THE DIVISION OF APIARY INSPECTION.

BY D. W. ERBAUGH AND B. F. KINDIG.

BEES AND BEE DISEASES.

The business of keeping bees for the honey and wax they produce has been practiced for thousands of years. Honey and beeswax were among the first articles of commerce.



(a) Worker. (b) Queen. (c) Drone. (Original.)

Bee diseases are nothing new. Foul brood has been known to exist in Europe for two hundred years or more. Over a hundred years ago, in the eastern part of the United States, bees suffered greatly from a scourge supposed at the time to be caused by the bee-moth.

Not much is known of the early bee-keeping in our State, but enough has been found out to convince us that, then as now, the apiarist had his troubles. Bees would die, usually from an unknown cause and occasionally to such an extent as to sweep the territory almost clear of bees.

During the last sixty years bee-keeping in Indiana has kept pace with other pursuits. The log gum, straw skep and box hives are still found in use, but have nearly all given way to the modern movable-frame hive.

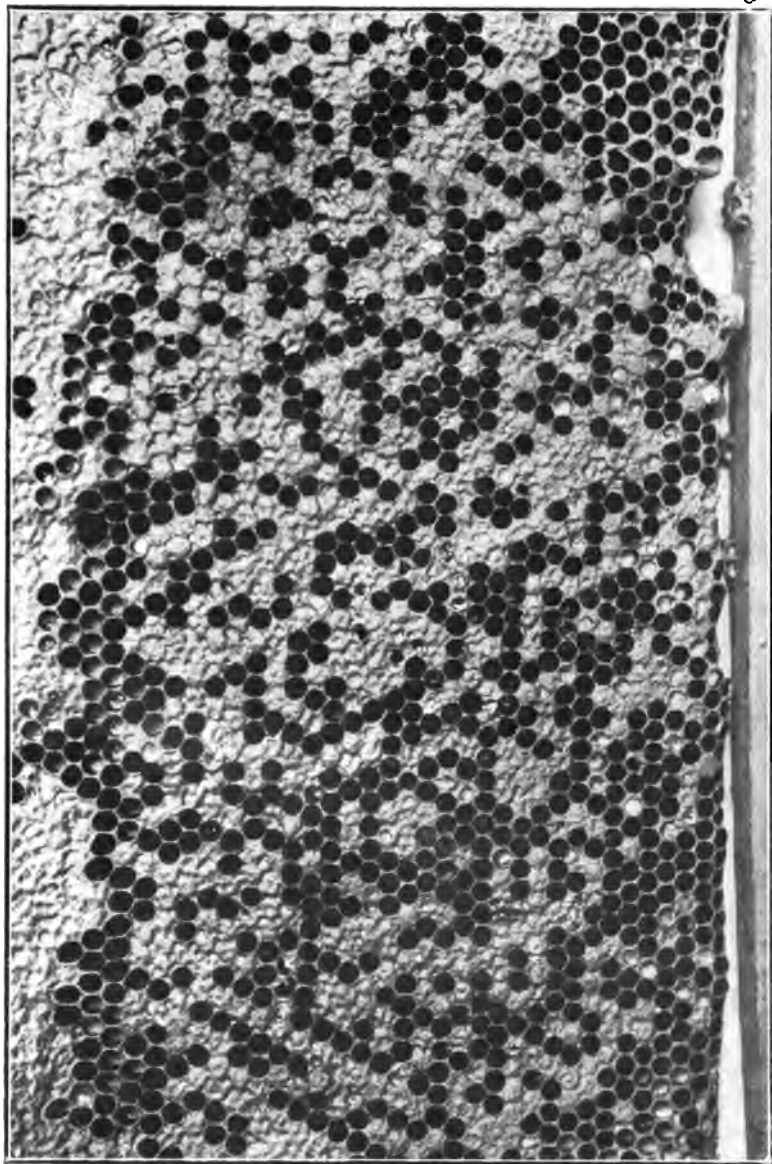
There are now five known diseases among the bees of Indiana. Three of these are brood diseases, two of which, American foul brood and European foul brood, are contagious; the other, pickled brood, is said not to be contagious.



AN APIARY OF LOG GUMS AND BOX HIVES. (Original.)



THE STRAW SKEP. (Original.)



AMERICAN FOUL BROOD. (Original.)

These three diseases, as has been said, do not affect the adult bees. The remaining two maladies are dysentery and paralysis. These affect only the adults.



AN UP-TO-DATE HIVE. (Original.)

AMERICAN FOUL BROOD.

American foul brood is supposed to be the first brood disease introduced into Indiana and is yet generally called foul brood. This is a bacterial disease caused by *Bacillus larvæ* which was discovered by Dr. G. F. White, Expert in Bacteriology, Department of Agriculture, Washington, D. C.

Although not diseased the adult bees of an infected colony are much inclined to loaf. They desert the super and finally, on hot days, leave the brood nest to join the cluster on the outside of the hive. When this stage is reached the disease may usually be detected by the peculiar odor in the yard. American foul brood usually attacks only the worker larvæ and that generally at a late stage, but sometimes before sealing. Most of the larvæ die just after the cells are sealed. The capping of the sealed cells, instead of being rounded or bulged are sunken, somewhat of a darker color and many have irregular holes eaten into them by the bees. Sometimes after the brood is nearly all sealed it is made ragged in appearance by these perforations. When death occurs before the cells are capped the larvæ at first lose their pearly, glistening

whiteness, turn yellow and all shades of brown until in the form of scales on the lower cell walls they become almost black. They also may at first lose their form and soon become ropy. If a tooth-pick or other similar object be inserted into a dead larva and withdrawn the matter may cling to it and string out an inch or more. Owing to the elevation of the outside of the cell the mass of decaying matter is sometimes deeper at the back and thinner at the front of the cell, making it appear to be shingled off. When death occurs at a later stage it sometimes happens that the head of the bee holds its form but dries down very small with its tongue protruding toward and maybe against the upper cell wall.



EIGHT FRAMES OF AMERICAN FOUL BROOD FROM ONE HIVE. (Original.)

EUROPEAN FOUL BROOD.

European foul brood, often called black brood, was found just recently by Dr. G. F. White to be caused by *Bacillus pluton*. This disease invaded our State a few years later than American foul brood. It is not so surely fatal, but when it is found in an apiary or neighborhood many more colonies are diseased than where American foul brood is the trouble.



THE APIARY OF E. S. HUDSON. (Original.)

In this disease the larva may die at any stage of development, quite frequently while yet curled up on the bottom of the cell, but sometimes after being capped over. The first symptoms are a loss of color and a small brown spot near the head. The decaying matter may become somewhat ropy. An odor may be present, but not to the extent that it is in cases of American foul brood, although in severe cases it is sometimes easily noticeable before the hives are opened. The little brown, dead larva curled up in the bottom of the cell is the most prominent feature of this trouble. They frequently take sick later and before the cell is capped over, at which stage the larvæ may be seen to move in the cells, getting out of position before death. Most of these dead larvæ are carried out by the bees, and a few of them dry down to scales which are black, irregular and loose in the cells.

It is very difficult at times to determine whether the trouble is European foul brood or some other brood disease.

PICKLED BROOD.

Pickled brood, the cause of which is unknown, is another disease affecting the larvæ of the bee. It is thought not to be contagious and is not nearly so prevalent in our State as either American foul brood or European foul brood.

Death usually occurs rather late in the development of the larvæ. They are generally lying lengthwise of the cell with the head small, dark and pointing upward. Some cells may be sealed and the cappings are sometimes perforated.

This affection is not often troublesome but may be found in neighborhoods where no other diseases appear. In a few apiaries in Indiana it has been quite serious—nearly all the colonies being diseased.

The disease usually disappears in time without much material hindrance to the work of the colony. An exchange of combs and especially a change of queens helps matters much.

OTHER BROOD DISEASES.

Brood may die from various other causes. It sometimes gets too hot or too cold and it is sometimes insufficiently fed. Brood, dead from these troubles, may be found in any stage of development. This often occurs where artificial swarming has been prac-

ticed or where the brood has been spread, and it may be found in the strongest colonies as well as in the weak ones. Dead brood is always removed by the bees unless they are very weak. It need not be mistaken for foul brood.

PARALYSIS.

This is a peculiar disease of the adult bees only. The cause of the trouble is unknown. The particular bee affected is nervous, dark and glossy and if it does not leave the hive it will soon be dragged out by the workers and left to crawl away and die. Feeble attempts to fly are often made by those dragged outside the hive. The disease is not frequent in Indiana, only three cases being found this season. There is no known remedy. It is not fatal in our State, the colony usually recovering the second season or sooner.

DYSENTERY.

Dysentery affects only the adult bees. It is caused by moist quarters, long confinement or improper food. In severe cases the abdomen of the bee becomes distended to such an extent that it is compelled to discharge its excrement within the hive, thus soiling the combs and only aggravating the trouble. A flight on a warm day is the only relief and if this is not repeated soon and often no permanent cure is brought about.

When contracted early in the winter, especially when caused by improper food, this trouble is usually fatal, or at best the colony comes out in the spring in a very much weakened condition.

If the colony be fed, after the queen ceases to lay in the fall, a quantity of syrup made from two parts of granulated sugar to one of water, much will be done to prevent the trouble.

Other Pests.

THE BEE-MOTH.

This at one time was considered the worst pest the bees had. It still has its terrors for many owners of bees in Indiana. Its easiest victim is the black bee and that will defend itself from the ravages of the moth unless queenless or much weakened. The Italian bee is very much less subject to the attack of this enemy.

If a colony dies from foul brood it is nearly always soon a

tangled mass of webs and cocoons from this moth. Although the foul brood germ is not destroyed by the moth the danger of infection from a hive in which the old combs were thus destroyed is very much lessened. Bees are adverse to entering a hive the inside of which is entangled with webs.

ANTS.

Ants delight to nest about colonies of bees, usually above the brood chamber. They are attracted there, no doubt, by the smell of the honey and the warmth of the bees. They never enter the brood nest when the bees are not disturbed, but when the hives are opened the ants run down over the frames and bees only to be dragged out by the workers and possibly cause the bees to be more irritable. The above and the annoyance of having the ants run over the bee-keeper's hands while at work is the extent of the nuisance.

Catnip crushed and left about their haunts will do much to alleviate the nuisance.

MICE.

Mice sometimes become quite a pest by making their homes within the bee hives during the winter season. They often gnaw great holes in the combs near the cluster and build their nests in these holes. They frequently work their way up into the packing and nest there. Mice are very active in the winter and become quite an element of disturbance. They eat both honey and dead bees. They may be kept out by contracting the entrance of the hive to about $\frac{3}{4}$ of an inch.

SUMMARY OF INSPECTION WORK OF 1912.

On account of the unfavorable weather during the spring and early summer, the inspection work was interfered with to such an extent that it was impossible to visit many apiaries until the season had advanced well into the honey-flow. Inspection during the honey-flow is slow and tedious, both on account of the large number of bees in the hives, and also because of the extra labor in handling supers. In spite of the somewhat adverse conditions, we find at the close of the season that the work has been quite satis-



PITY THE BEES. (Original.)



THE APIARY OF CHAS. KENNARD, KNIGHTSTOWN, IND. (Original.)

factory. All requests for inspection have been cared for and the end of the season finds the field work well in hand. The work done in the field was as follows:

| | |
|--------------------------------------|-------|
| Apiaries visited..... | 202 |
| Colonies inspected..... | 2,574 |
| Cases of American foul brood..... | 222 |
| Cases of European foul brood..... | 72 |
| Cases of pickled brood..... | 34 |
| Cases of paralysis | 3 |
| Box hives found..... | 44 |
| Frame hives with crossed combs..... | 57 |
| Diseased hives burned..... | 64 |
| Foul brood demonstrations given..... | 9 |

DEMONSTRATIONS.

In June it was determined that hereafter the inspectors would give foul-brood demonstrations wherever the conditions would justify them. The procedure is, first to inspect all the apiaries in the locality and, at the end of the inspection, to call together the bee-keepers at some centrally located apiary where foul brood is present. In the evening after the bees have quit flying, one colony is treated as an example of the proper methods to pursue. While doing this the reasons for each step are given and sufficient time is used so that each one present may thoroughly understand the methods and the reasons for all operations in the treatment. Many very complimentary reports have come in as a result of the work and it shall be the policy of this office to follow this plan in the future. Demonstrations were given at the following places: Aylesworth, Hebron, Knightstown, Elkhart, Maxwell, Ft. Wayne, Berne, Mohawk and Winchester.

TREATMENT OF FOUL BROOD.

While it is self-evident that no written description of the treatment for foul brood can compare in value to a practical demonstration of the treatment, yet, in view of the fact that the number of bee-keepers is so great and the number of inspectors is so small that it is physically impossible to give a demonstration in every locality, it is deemed advisable to give as accurate a description of the method as possible.



APIARY OF O. I. MASTON INDIANAPOLIS, IND. (Original.)

If practicable the colony should be treated during the honey-flow; the earlier the better, provided there is enough nectar to furnish food. If treated early in the season the bees will have more time to build comb and store surplus. It must not be inferred that in all localities the bees must be treated in May or June to be successful, for they may be treated later with equal success, but the later the treatment is given the less surplus honey will be stored. It must be emphasized that the treatment should be given during a honey-flow, for at other times there is a greater or less tendency to rob and whenever robbers are about one cannot treat the disease with safety. Particular precautions should be taken to treat the bees in the evening after they have quit flying. Also, all adjacent hives should be effectively closed so that bees from the diseased colony, in the confusion attending the transferring, do not get into the wrong hives and so carry the disease with them.

Everything needed in the work should be at hand before beginning the actual transferring. The new hive with narrow strips of starter in the frames should be prepared; a hole the size of a large butter-bowl should be dug near the diseased colony and filled with kindling wood; turkey feathers or a brush that may be destroyed after using should be procured. Then set the diseased colony a few feet to one side and put the prepared hive in its place with the running board in position. Place newspapers over the ground about the hives wherever there is any danger of honey dripping on the ground. Open the diseased colony and, taking out one frame at a time, shake and brush the bees in front of the entrance to the prepared hive. As soon as all the bees are off the combs, place combs on the pile of kindling. After all the frames have been taken out of the old hive, dump the bees that remain in it in front of the new one. Smoke them a little to hurry them into the hive. As soon as most are inside and it is positively known that the queen is not outside, put a queen guard over the entrance. Then light the fire. Keep the guard on for a few days to prevent absconding. This is more necessary when the honey-flow is light. **THEN CLEAN UP.** Cleanliness is the greatest virtue in treating foul brood. Burn up the papers used to catch the dripping honey. Stir up the burning combs so that they will be entirely consumed. Then cover the ashes with dirt so that any honey not burned will be hidden from the bees. Then thoroughly char the whole interior of the old hive and set it away for future use. Canvas or cloths used over the brood frames should not be used

again. The charring of the hive may be done by means of a gasoline blow-torch or by setting the hive-body over a good fire. The propolis catches fire and burns readily. The charring must be done thoroughly in order to be able to use the hive again with safety.

THE EDUCATIONAL FEATURES OF INSPECTION.

One of the purposes of inspection is to acquaint the bee-keepers with the symptoms of foul brood and to make them sufficiently familiar with the aspects of the disease so that they may recognize it if it ever appears in their apiaries. It is a bee-keeper's duty, in justice to himself, to keep his bee-keeping neighbors and beginners in the business informed in regard to disease conditions. It is the object of the demonstrations that they be educative. It is to be hoped that sometime every beekeeper in the State will be able to diagnose and treat foul brood correctly. The eradication of the bee diseases is an educative problem and the quicker every beekeeper understands foul brood and takes it upon himself to see that his neighbors become familiar with it, the sooner will an eradication of the malady be brought about. Some of the largest beekeepers even go so far as to buy up diseased colonies and treat them at detention yards. This is one of the surest ways of making one's neighborhood free from the disease, but it involves considerable expense and labor. Education may eventually bring about the same result, but it will come gradually.

When an inspector goes to a part of the State where there has never been an inspection, the bee industry is usually found in a sorry plight. In many instances the farmers say that bees used to be kept in considerable numbers but now only an occasional colony is found. The disease has simply killed almost every colony. In other places where the disease has more recently become established, it is found in from 15 per cent. to 75 per cent. of the colonies. In such localities it is a common custom to hive the swarms that issue on the diseased combs of a dead colony. This, of course, ends in failure. It is only a question of a short time until the once busy apiary becomes a pile of diseased hives stacked in one corner of the lot. This is an example of the conditions usually prevailing in localities where an inspector has not visited or bee-keepers have not kept up-to-date through bee journals, Department of Agriculture bulletins and other literature. When an inspector finds a bee-keeper who takes and reads a good bee journal,

he almost invariably finds a man who is awake to the foul brood problem. The time has been when one could be a successful fruit-grower without spraying, and when one could be a successful apiarist without thinking of the foul brood problem; but conditions have changed, and today fruit-growers and bee-keepers of that class are hopelessly out of the race.



APIARY OF F. M. HAYNES, MOLOC, INDIANA. (Original.)

A survey of the conditions existing in those parts of the State where inspection has been carried on during previous seasons shows that the amount of foul brood has decreased very greatly where the bee-keepers have conscientiously followed the directions of the inspectors. In one locality in the Ohio River district, three years ago, there were several hundred cases of foul brood. During the past summer 644 colonies were inspected in that neighborhood and only one case of foul brood was found. This is a concrete example of what bee-keepers working in harmony may accomplish.

WINTER-KILLING AND FOUL BROOD.

The foul-brood situation was aggravated considerably within the last year on account of the very unfavorable winter. Many

diseased colonies which might have lived over a mild winter were frozen to death and the disease-bearing honey which was left in the hive was robbed out in the spring. Thus the disease was carried to many healthy colonies and, as a result, very many incipient cases of foul brood were found. Bee-keepers should exercise particular care to contract the entrances to weak colonies and entirely close the entrances to dead ones so that robbing may not take place. This precaution, if carefully followed, would prevent a very large number of colonies from contracting the disease. If there is the slightest reason for believing that the colony may have died from foul brood or was frozen out because of the weakness induced by foul brood, the only safe way to dispose of the hive is to treat it the same as if foul brood were positively known to be present. Trying to save a little beeswax or honey frequently turns out to be very expensive economy.

SOME CAUSES OF FAILURES IN TREATING FOUL BROOD.

People always have failed in many of their undertakings. The chances are they always will. The treatment of brood diseases in bees is no exception. Often the bee-keeper finds, after making an honest effort to cure the diseased bees, according to the directions of the best apiarists, that he has failed to rid them of the infection. Here, again, is no exception: the cause of the failure is not always apparent; but a careful examination into the mode of such an unsuccessful effort usually discloses the fact that at least one of the essentials of correct treatment was omitted.

In spite of the fact that instructions are always given to treat in time of honey-flow, some bee-keepers attempt to treat foul brood when no honey is coming in. This usually results not only in a failure to cure the one treated, but is more than likely to cause the disease to be scattered among the neighboring hives by robbers.

Frequently the bees have a way of leaving the hive or absconding when first put in either at swarming time or at the time of treatment for foul brood. Thus the swarm is a total loss. Just why they do this is not always known. Shade and an ample brood nest for a few days do much to cause them to stay at home. The only sure method though, is to compel the queen to stay within the hive, either by caging her or by placing a queen guard at the entrance until they become established in their new home.

It is not an unusual occurrence to find foul brood breaking out afresh near the colony last treated. Failure to close the entrance

to the adjoining hives and all others near the one being treated, is a factor against the success of the work. During the transfer the bees usually become much confused and may enter any open hives near by. These newcomers are often accepted and allowed to unload the infected honey brought with them. The bee-keeper may be ever so careful and painstaking in his treatment of foul brood and yet fail. Much depends on the weather. A sudden change after treatment from warm, balmy days to continued cold or rainy weather, greatly weakens the chances for success. In such cases liberal feeding may help matters but nothing will take the place of proper outside conditions.

WINTERING BEES.

This article is not written to give definite directions for putting bees away for the winter, nor for the purpose of discussing the merits of cellar-wintering and those of wintering outside, but mainly with a view to call attention to the importance of the subject and to a few of the obstacles to successful wintering.

To know how to tuck bees away for the winter and to practice what is known, are two qualifications some bee-keepers in Indiana do not possess. More bees have died within the last year in our State because they were not properly prepared for winter, than have died in several years from foul brood. Very many bee-keepers who manage their bees well during the swarming season and the honey-flow fail altogether to get them ready for winter.

Cellar-wintering is successfully practiced only by the expert. A number of bee-keepers in northern Indiana winter their bees in the cellar. No doubt that method could be carried on to advantage in severe seasons much further south.

The weather in Indiana, except in the northern part, is usually such as to make it preferable to winter outside. Generally the winters are mild enough to permit the bees to take an occasional flight. Again the season may be so severe as to keep the bees housed up for months at a time.

The unprotected colony even in mild winters comes out in the spring in a much weakened condition. If the season happens to be severe it usually dies.

Moisture is constantly passing off from the bees in the hive. In the summer season this passes out from the brood-chamber and the supers, doing no harm. But not so in the winter.

When the weather is cold and the warm, saturated air within the hive comes in contact with the walls and especially the cover of the hive, the air becomes chilled and loses part of its moisture, which collects mostly on the hive cover only to fall in great drops of water on the cluster of bees below. How to get rid of this moisture without causing a draft or too much ventilation is the problem in wintering bees.

Most of the bees in Indiana are left through the winter in such a condition as to aggravate this trouble. Oilcloths are left over the brood nest just as they were placed when the surplus honey was taken off, or perhaps wooden covers are sealed down with no other protection.

Now oilcloths may be all right in warm weather, but very bad in winter. Burlap or some other porous cloth should be substituted for the oilcloth, with a few inches of absorbent packing on top. This packing may be forest leaves, planer-shavings or chaff. This helps to retain the heat from the bees and allows the moisture to pass off without a draft. The hive with the sealed cover should be wrapped in building paper, enclosing a few inches of absorbent material all around the hive, thus preventing the sudden chill of the moist air inside and allowing the vapor to pass out at the entrance as in the warm season.

Different hives have different properties, making them better or worse for wintering. When the weather is cold bees appear to be able to move up or down much more readily than in other directions. This is one of the reasons that bees winter better in the deeper frames. But then, a closed-end frame is much to be preferred to a loose-hanging one. The double-walled hive, so made mainly for the purpose of insuring good wintering, is coming into favor generally and is used by many bee-keepers in our State. The winter case, too, is excellent for this purpose. It is put on during the winter but taken off when the weather turns warm in the spring. Some bee-keepers winter their bees very successfully in tenement hives, each holding four or more colonies. The hives may be placed in a row, packed all around and then enclosed with boards. These boards and packing should of course be removed in the spring.

All hives should be in such position as to allow the sun to shine upon the entrance sometime during the day. It is well to remember that the main object is to keep the bees dry and warm. Plenty of honey and a good-sized cluster kept dry insures success.

LITERATURE FOR BEEKEEPERS.

In answer to many inquiries relative to available bee literature, the following list of the more common publications is given:

Cir. No. 94, Bureau of Entomology, The Cause of American Foul Brood.

Bul. No. 75, part 2, Bureau of Entomology, Wax Moths and American Foul Brood.

Bul. No. 75, part 4, Bureau of Entomology, Relation of the Etiology (cause) of Bee Diseases to the Treatment.

The above may be obtained free by writing to the Editor in Chief of the Division of Publications, U. S. Department of Agriculture, Washington, D. C.

Farmers Bul. No. 397, Bees.

Farmers Bul. No. 442, Treatment of Bee Diseases.

Farmers Bul. No. 503, Comb Honey.

The above may be obtained by writing to your U. S. Senator or Representative or by addressing the Secretary of Agriculture, Washington, D. C.

The following books are practical and trustworthy. They may be ordered through your local book stores, dealers in bee-keepers' supplies, from most of the bee-keepers' magazines or from the publishers:

The Bee-keepers' Guide or Manual of the Apiary, by A. J. Cook. Price, postpaid, \$1.15.

How to Keep Bees, by Anna Comstock. Published by the A. I. Root Co., Medina, Ohio. Price \$1.10, postpaid.

A B C and X Y Z of Bee Culture. Published by the A. I. Root Co., Medina, Ohio. Price \$1.50, postpaid.

Advanced Bee Culture, by W. Z. Hutchinson. Price \$1.10, postpaid.

Scientific Queen Rearing, by G. M. Doolittle. Published by Geo. W. York & Co., Chicago, Ill. Price \$0.80, postpaid.

The above list of books and publications do not by any means include all that are available but they are intended to be a representative list of reliable material. Below is given a list of bee journals. Every up-to-date bee-keeper generally takes one or more of these journals.

The Bee-keepers' Review, Detroit, Mich., the official organ of the National Bee-keepers' Association. Price \$1.00 per year.

Gleanings in Bee Culture, Medina, Ohio, the famous publication of the A. I. Root Co. Price \$1.00 per year.

American Bee Journal, Hamilton, Ill., edited by the well known authority, Mr. C. P. Dadant. Price \$1.00 per year.

THE INDIANA BEE-KEEPERS' ASSOCIATION.

There is an Indiana branch of the National Association. Meetings are held annually at Indianapolis. Last winter the association secured as speakers Dr. E. F. Phillips, Chief of the Division of Apiculture, U. S. Department of Agriculture, Washington, D. C., and the well known authority Ernest R. Root of the A. I. Root Co., Medina, Ohio. Mr. Geo. W. Williams of Redkey, Ind., is the Secretary of the Indiana Branch. The membership fee of the Indiana Bee-Keepers' Association is fifty (\$0.50) cents per year. The membership fee of both the Indiana and the National Association is one (\$1.50) dollar and fifty cents. This includes a year's subscription to the Bee-Keepers' Review, the official organ of the National Bee-Keepers' Association.

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ERRATA.

- Line 36, p. 8, for "results of it," read "fruit produced."
- Line 37, p. 22, for "fruit tree bark beetle" and "peach tree borer," read "fruit-tree bark-beetle" and "peach-tree borer."
- Page 33, in spray calendars and elsewhere for "lime sulphur," read "lime-sulphur."
- Line 3, p. 44, for "*Larva*," read "*Life history*."
- Line 13, p. 69, for "destroys," read "destroy."
- Line 18, p. 72, for "wings," read "wing-pads."
- Line 22, p. 74, for "preceding," read "this."
- Line 24, p. 78, for "underside," read "under side."
- Line 29, p. 87, for "*Coleophara*," read "*Coleophora*."
- Line 3, p. 89, for "very fine," read "quite small."
- Line 17, p. 90, for "underside," read "under side."
- Line 8, p. 107, for "are entirely root feeders," read "is entirely a root feeder."
- Line 3, p. 116, for "inch," read "inches."
- Line 28, p. 116, for "their," read "its."
- Lines 12 and 13, p. 119, for "are" and "their," read "is" and "its."
- Line 15, p. 122, for "have," read "has."
- Line 24, p. 126, for "folige," read "foliage."
- Line 35, p. 137, for "cucurbitateous," read "cucurbitaceous."
- Line 4, p. 145, for "domage," read "damage."
- Line 21, p. 146, for "larva," read "larvæ."
- Line 28, p. 150, for "frugeperda," read "frugiperda."
- Line 30, p. 158, for line omitted, read "the end of the body and perpendicular to it."
- Line 37, p. 168, for "owners," read "tenants."
- Line 28, p. 169, for "a brown heads," read "brown heads."
- Line 6, p. 170, for "are," read "is."
- Line 35, p. 171, for "out of doors," read "out-of-doors."
- Line 15, p. 174, for "eggs," read "egg-cases."
- Line 16, p. 182, for "out of doors," read "out-of-doors."
- Line 3, p. 184, for "larva," read "nymph."
- Line 29, p. 192, for "they," read "Tepismas,"



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